Field Columbian Museum
Publication 120

Geological Series Vol. III, No. 5.

ANALYSES OF IRON METEORITES COMPILED AND CLASSIFIED

by
Oliver Cummings Farrington,
Curator, Department of Geology

Chicago, U. S. A.
March 1, 1907.

ANALYSES OF IRON METEORITES COMPILED AND CLASSIFIED

BY

OLIVER CUMMINGS FARRINGTON

Chemical analyses may be collected and grouped for purposes of record and of comparison. For the first purpose it is desirable that all known analyses of the substances under consideration be collected; for the second, only those known to be complete and reliable are needed. A combination of these two purposes may perhaps be gained, however, by collecting all analyses and leaving to the judgment of the investigator the selection of those suited for the study of any particular phase of the subject. This plan is practically that which has been adopted in presenting the analyses here collected. In many cases obviously incomplete analyses are given because they represent all that is known of the chemical constitution of the meteorite in question, or because they mark a stage in its study. On the other hand, analyses which amount to little more than a qualitative determination of the presence of iron and nickel, or whose connection with a particular meteorite is uncertain, are omitted. About three hundred and sixty analyses are here included, and it is believed that they comprise practically all of importance that have been made of iron meteorites. When more than one analysis of a meteorite is given, the analyses have been arranged chronologically. For the most part the later analyses are the most complete and reliable ones, though this is not always the case. Thus those by J. Lawrence Smith, although made thirty and in some cases forty years ago, accord well with what is known of the constitution of the iron meteorites at the present day and may be considered generally accurate and reliable. The same is true of analyses by Jackson, Berzelius, Damour, and others. As shown later, the relations between structure and composition brought out by the analyses as here grouped are so definite that at the present time a knowledge of the structure of a meteorite will give a more accurate idea of its composition than inferior chemical analyses. The general plan of arrangement which has been adopted for the analyses is that now generally known as the Rose-Tschermak-Brezina classification. This seemed the classification most desirable to employ on account of its wide use, and when it was found, as will be seen by the tables, that the chemical constitution of the meteorites follows its main divisions, its adaptation to the work in hand seems unquestionable. Under each group of the classification the arrangement of the meteorites is alphabetical. Synonyms of the meteorite names will be found on subsequent pages. The characterization of the meteorite groups which head the tables have largely been summarized from Cohen.* In considering the analyses it should be realized that some of the groups are much better known than others. Thus the ataxites and hexahedrites were thorougly studied by Cohen and their composition satisfactorily determined. The fine octahedrites have also been mostly investigated. The coarse and medium octahedrites, however, though more numerous than the groups just mentioned, are but imperfectly known and need detailed modern study. In a list following the tables meteorites of which no analysis is known are marked with an asterisk. These number about forty. In addition, many meteorites, analyses of which are reported in the tables, have never in fact been properly studied. The only extensive list of analyses of iron meteorites which has lately been previously compiled of which the writer is aware is that of Wadsworth, published in 1884.† This list includes one hundred and ninety-three analyses of iron meteorites and terrestrial irons, arranged in order of the per cent of nickel. No further attempt at classification is made. While Wadsworth's list is fairly complete as regards older analyses, it includes several pseudo-meteorites, and obviously does not adequately represent present knowledge.

The first recorded attempt at analysis of an iron meteorite is probably to be found in the examination in 1802, by Count de Bournon,‡ of some so-called native irons from Bohemia, Senegal, and South America. In these Count de Bournon found percentages of nickel ranging from five to ten per cent, but it is stated by Howard elsewhere in the paper that owing to lack of knowledge of the peculiarities of nickel these figures are little more than estimates. The next year Klaproth § reported one and one-half to three and one-half per cent of nickel in the iron meteorite of Hraschina, and expressed the opinion that the presence of nickel might serve as a criterion for

* Meteoritenkunde, Heft III.

† The Rocks of the Cordilleras, Memoirs Museum Comparative Zoölogy, Cambridge, Mass., Vol. XI, Part I, pp. vi–xvi, Table II.

‡ Phil. Trans. Roy. Soc., London, 1802.

§ Abhandl. Akad. Wiss., Berlin, 1803, 21–41.

judging the meteoric origin of a body. Cobalt was reported by Stromeyer in the iron meteorite of Cape of Good Hope in 1816,* and copper by the same investigator in 1833.† Stromeyer expressed the belief that copper was, with cobalt, a constant ingredient of meteoric nickel-iron, and this conclusion was later corroborated by Smith‡ on the basis of more than one hundred analyses. Chromium was discovered as a component of meteoric nickel-iron by Laugier in 1817.§ The presence of manganese and tin in meteoric nickel-iron was also early reported. The presence of other metals or semi-metals reported at different times, such as zinc, lead, arsenic, and antimony, has not been confirmed, while the presence of aluminum, calcium, magnesium, potassium, and sodium, noted by several analysts, is doubtless to be referred to small quantities of silicates which either formed a constituent of the meteorite, as in Tucson, Tula, etc., or accidentally contaminated the material analyzed. The occurrence of phosphorus in meteoric nickel-iron seems first to have been noted by Berzelius ‖ in the undissolved residue of Bohumilitz. It was similarily reported by analysts who followed Berzelius, but percentages were not commonly given until later times. Sulphur was early noted as an ingredient of meteoric stones and later of irons. Since it occurred as a soluble constituent, it was more often reported in the early analyses than phosphorus. The presence of carbon as graphite was noted by Tennant¶ in 1806 in the Cape of Good Hope meteorite. Being, like the phosphides, insoluble, its presence was often later reported in insoluble residues, but its amount was rarely given. Silicon, as reported in the earlier analyses, whether as metal or oxide, is probably for the most part to be referred to accessory silicates. With later methods, however, its detection in small quantities as an ingredient of the nickel-iron has become possible. The first detection of chlorine as an essential constituent of iron meteorites seems to have been by Jackson in 1838,** in the meteorite of Limestone Creek. Its presence has been occasionally but not commonly reported by later analysts. Determinations of specific gravity of the iron meteorites examined seem to have been common. While these are probably for the most part fairly reliable, some of the values reported are too anomalous to seem trustworthy.

* Gottingische Gelehrte Anzeigen, 1816, 2041-2043.

† Gottingische Gelehrte Anzeigen, 1833, 369-370.

‡ Am. Jour. Science, 1870 (2), 49, 332.

§ Ann. Chem. Pharm., 1817, IV, 363-366.

‖ Pogg. Ann., 1832, XXVII, 128-132.

¶ Tillochs Phil. Mag., London, 1806, XXV, 182.

** Am. Jour. Science (1), 34, 332-3?7.

IRON METEORITES.

These are meteorites consisting essentially of nickel-iron. Most of them contain, in addition, an appreciable amount of sulphides, carbides, and phosphides, but the presence of silicates in quantity removes a meteorite from this class. The iron meteorite of Tucson contains about five per cent of forsterite, and the meteorites of Kodaikanal, Persimmon Creek, and Tula also contain silicate aggregates, but in small quantities. In general, it may be said that if the quantity of silicate grains exceeds five per cent the meteorite is not considered as belonging to the class of iron meteorites. About two hundred and fifty iron meteorites are now recognized, the exact number being indeterminate on account of differences of opinion as to identity of origin in several cases. The chief divisions of iron meteorites, according to the Rose-Tschermak-Brezina classification, are hexahedrites, octahedrites, and ataxites. These are sub-divided as follows:

CLASSIFICATION OF IRON METEORITES ACCORDING TO ROSE, TSCHERMAK, BREZINA, AND COHEN

I. Hexahedrites.
- A. Normal hexahedrites.
- B. Brecciated hexahedrites.

II. Octahedrites.
- A. Normal octahedrites.
  - 1. Coarsest octahedrites.
  - 2. Coarse octahedrites.
  - 3. Medium octahedrites.
  - 4. Fine octahedrites.
    - *a.* Prambanan group.
    - *b.* Rodeo group.
  - 5. Finest octahedrites.
    - *a.* Salt River group.
    - *b.* Tazewell group.
    - *c.* Cowra and Victoria West.
- B. Hammond octahedrites.
- C. Brecciated octahedrites.

III. Ataxites.
- A. Nickel-poor ataxites.
  - 1. Siratik group.
  - 2. Nedagolla group.
  - 3. Rafruti group.

B. Nickel-rich ataxites.
  1. Smithland group.
  2. Cristobal group.
  3. Octibbeha.
C. Ataxites with forsterite.
D. Ataxites with cubic streaks.

The iron meteorites enumerated according to groups sum up as follows:

Octahedrites:	
Coarsest	13
Coarse	30
Medium	98
Fine	33
Finest	14
Brecciated	6
Hammond	3
Unclassified	4
	201
Ataxites	30
Hexahedrites	17
Total	248

ALPHABETICAL LIST OF IRON METEORITES.

The following is an alphabetical list of iron meteorites, showing the classification of each. An asterisk indicates that no analysis of the meteorite is reported.

Abert Iron	Medium octahedrite
*Adargas	Medium octahedrite
Algoma	Medium octahedrite
Alt Biela	Fine octahedrite
*Amates	Medium octahedrite
Angara	Medium octahedrite
*Apoala	Fine octahedrite
Arispe	Coarsest octahedrite
Arlington	Medium octahedrite
Asheville	Medium octahedrite
Auburn	Hexahedrite
Augustinowka	Fine octahedrite
Babb's Mill	Ataxite
Bacubirito	Finest octahedrite
Bald Eagle	Medium octahedrite
Ballinoo	Finest octahedrite
Barranca Blanca	Brecciated octahedrite
Beaconsfield	Coarse octahedrite
Bear Creek	Fine octahedrite
Bella Roca	Fine octahedrite
Bendego	Coarse octahedrite
Bethany	Fine octahedrite
Billings	Coarse octahedrite
Bingera	Hexahedrite
Bischtube	Coarse octahedrite
Black Mountain	Coarse octahedrite
*Blue Tier	Medium octahedrite
Bohumilitz	Coarse octahedrite

Boogaldi..........Fine octahedrite
Botetourt..........Ataxite
Braunau............Hexahedrite
Bridgewater.......Fine octahedrite
Buckeberg.........Fine octahedrite
Burlington.........Medium octahedrite
Butler.............Finest octahedrite

Cabin Creek.......Medium octahedrite
Cacaria...........Hammond octahedrite
Cachiyuyal.........Medium octahedrite
Cambria...........Fine octahedrite
Campo del Cielo...Ataxite
Canton............Coarsest octahedrite
Canyon Diablo.....Coarsest octahedrite
Canyon City.......Coarse octahedrite
Cape of Good Hope.Ataxite
Caperr............Medium octahedrite
Cape York.........Medium octahedrite
Carlton...........Finest octahedrite
Carthage..........Medium octahedrite
Casas Grandes.....Medium octahedrite
*Casey County......Coarsest octahedrite
Central Missouri...Coarsest octahedrite
*Chañaral..........Coarse octahedrite
*Charcas...........Medium octahedrite
*Chambord.........
Charlotte..........Fine octahedrite
Chesterville........Ataxite
*Chichimeguilas.....
Chilkoot...........Medium octahedrite
Chulafinnee........Medium octahedrite
Chupaderos........Fine octahedrite
Cincinnati.........Ataxite
Cleveland..........Medium octahedrite
Coahuila...........Hexahedrite
Colfax.............Medium octahedrite
Coopertown........Medium octahedrite
Cosby Creek.......Coarse octahedrite
Costilla............Medium octahedrite
Cowra.............Finest octahedrite
*Cranberry Plains...Octahedrite
Cranbourne........Coarse octahedrite
Cuba...............Medium octahedrite
Cuernavaca........Fine octahedrite

Dalton............Medium octahedrite
Deep Springs......Ataxite............
Dehesa............Ataxite
*Dellys.............Medium octahedrite
Denton County.....Medium octahedrite
Descubridora......Medium octahedrite
De Sotoville.......Hexahedrite
Duell Hill.........Coarse octahedrite

Elbogen...........Medium octahedrite
El Capitan.........Medium octahedrite
*El Tule...........Medium octahedrite
*Emmitsburg.......Medium octahedrite

Forsyth County....Ataxite
Fort Duncan......Hexahedrite
Fort Pierre........Medium octahedrite
Franceville........Medium octahedrite
Frankfort..........Medium octahedrite

Glorieta...........Medium octahedrite
Grand Rapids......Fine octahedrite
Greenbrier County..Coarse octahedrite
Groslee............Fine octahedrite
Guilford County....Medium octahedrite

Hammond.........Hammond octahedrite
*Haniel el-Beguel...Medium octahedrite
Hassi Jekna........Fine octahedrite
*Hayden Creek.....Medium octahedrite
Hex River.........Hexahedrite
Holland's Store....Hexahedrite
Hopewell Mounds..Medium octahedrite
Hopper...........Medium octahedrite
Hraschina.........Medium octahedrite

*Ilimae............Medium octahedrite
Illinois Gulch......Ataxite
Indian Valley......Hexahedrite
Iquique............Ataxite.............
Iredell.............Hexahedrite
Ivanpah...........Medium octahedrite

*Jackson County....Medium octahedrite
Jamestown.........Fine octahedrite
Jennie's Creek.....Coarse octahedrite
Jewel Hill.........Fine octahedrite
Joel's Iron.........Medium octahedrite
Joe Wright........Medium octahedrite
Jonesboro..........Fine octahedrite
Juncal............Medium octahedrite

Kendall County....Hexahedrite
Kenton County.....Mediumoctahedrite

*Kodaikanal	Fine octahedrite
Kokomo	Ataxite
Kokstad	Medium octahedrite
La Caille	Medium octahedrite
Lagrange	Fine octahedrite
Laurens County	Finest octahedrite
Lenarto	Medium octahedrite
Lexington County	Coarse octahedrite
Lick Creek	Hexahedrite
Limestone Creek	Ataxite
Linville	Ataxite
Locust Grove	Ataxite
*Lonaconing	Coarse octahedrite
Losttown	Medium octahedrite
*Lucky Hill	Medium octahedrite
Luis Lopez	Medium octahedrite
*Madoc	Fine octahedrite
Magura	Coarse octahedrite
Mantos Blancos	Finest octahedrite
Marshall County	Medium octahedrite
Mart	Finest octahedrite
Matatiela	Medium octahedrite
Mazapil	Medium octahedrite
Merceditas	Medium octahedrite
Misteca	Medium octahedrite
*Moctezuma	Medium octahedrite
*Mooranoppin	Coarsest octahedrite
Moonbi	Fine octahedrite
Morito	Medium octahedrite
Morradal	Ataxite
Mount Joy	Hexahedrite
*Mount Stirling	Coarse octahedrite
Mungindi	Finest octahedrite
Murfreesboro	Medium octahedrite
Murphy	Hexahedtite
*Nagy-Vazsony	Medium octahedrite
Narraburra Creek	Finest octahedrite
Nedagolla	Ataxite
Nejed	Medium octahedrite
Nelson County	Coarsest octahedrite
Nenntmannsdorf	Ataxite
N'Goureyma	Brecciated octahedrite
Niagara	Coarse octahedrite
*Nochtuisk	Coarse octahedrite
*Nocoleche	Medium octahedrite
Oktibbeha County	Ataxite
Orange River	Medium octahedrite
*Oroville	Medium octahedrite
Oscuro Mountains	Coarse octahedrite
Pan de Azucar	Coarse octahedrite
*Persimmon Creek	Brecciated octahedrite
Petropawlowsk	Medium octahedrite
Pittsburg	Coarsest octahedrite
Plymouth	Medium octahedrite
Ponca Creek	Coarsest octahedrite
Prambanan	Fine octahedrite
Primitiva	Ataxite
Puquois	Medium octahedrite
Putnam County	Fine octahedrite
Quesa	Fine octahedrite
Rafruti	Ataxite
*Rancho de la Pila	Medium octahedrite
Rasgata	Ataxite
Red River	Medium octahedrite
Reed City	Hammond octahedrite
Rhine Valley	Medium octahedrite
Rodeo	Fine octahedrite
Roebourne	Medium octahedrite
*Rosario	Octahedrite
Rowton	Medium octahedrite
Ruff's Mountain	Medium octahedrite
Russel Gulch	Fine octahedrite
Sacramento Mountains	Medium octahedrite
St. Francois County	Coarse octahedrite
St. Genevieve County	Fine octahedrite
Salt River	Finest octahedrite
San Angelo	Medium octahedrite
San Cristobal	Ataxite
San Francisco del Mezquital	Ataxite
*Santa Apolonia	
Santa Rosa	Brecciated octahedrite
Sao Juliao	Coarsest octahedrite
Sarepta	Coarse octahedrite
Schwetz	Medium octahedrite
Scottsville	Hexahedrite
Seelasgen	Coarsest octahedrite
Seneca Falls	Medium octahedrite

Shingle Springs....Ataxite
*Sierra Blanca......Coarse octahedrite
Silver Crown ......Coarse octahedrite
Siratik.............Ataxite
Smithland.........Ataxite
Smith's Mountain..Fine octahedrite
Smithville.........Coarse octahedrite
Ssyromolotow......Medium octahedrite
Staunton..........Medium octahedrite
Summit............Hexahedrite
Surprise Springs...Medium octahedrite

Tabarz............Coarse octahedrite
*Tajgha............Medium octahedrite
*Tanogami.........Medium octahedrite
Tazewell...........Finest octahedrite
*Teocaltiche........Octahedrite
Ternera...........Ataxite
Thunda...........Medium octahedrite
Thurlow...........Fine octahedrite
*Tlacotepec........Octahedrite
Toluca............Medium octahedrite
Tonganoxie........Medium octahedrite
Toubil............Medium octahedrite
Trenton...........Medium octahedrite
Tucson............Ataxite
Tula..............Brecciated octahedrite

*Union County......Coarsest octahedrite
Ute Pass..........Coarsest octahedrite

Varas.............Fine octahedrite
Victoria...........Medium octahedrite
Victoria West......Finest octahedrite

*Wallen's Ridge....Coarse octahedrite
Walker County.....Hexahedrite
Weaver...........Ataxite
Welland...........Medium octahedrite
*Werchne Dnieprowsk...........Finest octahedrite
Werchne Udinsk..Medium octahedrite
Wichita County....Coarse octahedrite
Willamette........Medium octahedrite
Wooster...........Medium octahedrite

Yanhuitlan.........Fine octahedrite
Yardea Station.....Medium octahedrite
*York..............Medium octahedrite
Youndegin.........Coarse octahedrite

Zacatecas..........Brecciated octahedrite

SYNONYMS.

The following are synonyms of the iron meteorites given in the preceding list:

Aeriotopos...........Bear Creek
Agram...............Hraschina
Ainsa................Tucson
Albuquerque..........Glorieta
Allen County.........Scottsville
Amakaken...........Caperr
Arva.................Magura
Atacama, 1858.......Joel's Iron
Atacama, 1874.......Cachiyuyal
Augusta County.......Staunton

Bahia................Bendego
Baird's Farm.........Asheville
Bates County.........Butler
Batesville............Joe Wright
Bonanza..............Coahuila
Brazos River..........Wichita
Butcher Iron..........Coahuila

Caille................La Caille
Caney Fork..........Carthage
Carleton Iron.........Tucson
Catorze..............Descubridora
Chatooga County......Holland's Store
Cherokee County, 1867: Losttown
Cherokee County, 1894. Canton
Chilkat...............Chilkoot
Claiborne............Lime Creek
Cocke County........Cosby Creek
Concepcion...........Adargas
Cross Timbers........Red River
Crow Creek..........Silver Crown

Dakota..............Ponca Creek

Ellenboro...........Colfax

Floyd County........Indian Valley

Floyd Mountain......Indian Valley

Great Fish River.....Bethany
Green County........Babb's Mill

Hamilton County.....Carlton
Hastings County......Madoc
Hauptmannsdorf .....Braunau
Henry County, 1857...Locust Grove
Henry County, 1889...Hopper
Honduras............Rosario
Howard County......Kokomo

Independence County.Joe Wright
Independence........Kenton County
Iron Creek...........Victoria

Johnson County.......Cabin Creek

Knoxville............Tazewell

La Primitiva..........Primitiva
Lea Iron.............Cleveland
Lime Creek, 1832.....Walker County
Lime Creek, 1834.....Limestone Creek
Lion River...........Bethany
Lockport.............Cambria

Miller's Run ....Pittsburg
Muchachos...........Tucson

Mukerop.............Bethany

Netschaevo..........Tula

Obernkirchen.........Buckeberg
Oldham County.......La Grange

Penkarring Rock.....Youndegin

Ranchito.............Bacuburito

Saltillo...............Coahuila
Sanchez Estate........Coahuila
San Gregorio ....Morito
Saskatchewan........Victoria
Senegal..............Siratik
Serrania de Varas.....Varas
Sierra de la Ternera..Ternera
Southeast Missouri....St. Francois County

Teposcolula..........Yanhuitlan
Tocavita.............Santa Rosa
Tombigbee River.....De Sotoville
Tucuman ....Campo del Cielo

Waldron's Ridge.....Wallen's Ridge
White Sulphur Springs............Greenbrier County
Whitfield County.....Dalton
Wohler's Iron........Campo del Cielo

ANALYSES OF IRON METEORITES.

I. HEXAHEDRITES.

The hexahedrites are characterized by cubic cleavage and Neumann lines. They consist of the single alloy kamacite, the composition of which, Fe_{14} Ni, shows a close approximation to the iron-nickel content of the hexadedrites. The content of phosphorus in the hexahedrites is usually relatively high, ¼ to ½ per cent. This appears char-

NORMAL

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Auburn..........	94.58	3.01	....	....	....	.13	....	.52	....	....	....	....
"	94.49	4.67	1.03	.101	.024	.46	.002	....	....	....	....	....
Braunau..........	91.88	5.52	.53	....	....	....	....	....	....	....	....	2.07
"	93.62	5.21	.92	.07	.05	.24	.08	.09	....	....	....	....
Coahuila..........	94.82	5.62	.60	....	tr.	.29	....	....	....	....	.06	....
(Bonanza)..........	97.90	2.10	tr.	....	tr.	tr.	....	....	....	....	....	Mg. tr.
(Butcher)..........	92.95	6.62	.48	tr.	....	.02	....	....	....	....	....	....
(Saltillo)..........	94.62	4.79	.60	.04	tr.	.18	tr.	....	....	....	....	....
(Santa Rosa)..........	96.07	3.26	.55	....	....	1.05	....	....	....	....	....	....
" "	91.86	7.42	.50	....	....	.27	....	....	....	....	....	....
De Sotoville..........	95.02	4.11	.40	....	....	.32	tr.	.16	....	....	....	....
"	95.14	4.82		.05	.01	.29	.06	....	....	....	....	....
"	95.18	4.32	.69	.04	....	.20	....	.07	....	....	....	....
"	95.41	4.04	.74	.04	....	.14	.05	....	....	....	.02	....
Fort Duncan..........	94.90	4.87		....	....	.23	tr.	tr.	....	....	....	....
" "	92.02	6.10		....	....	....	....	....	....	....	1.80	....
" "	91.90	7.03		....	....	....	....	....	....	....	....	....
" "	92.58	6.66	.73	....	....	.28	....	....	....	....	.01	....
" "	94.65	4.82	1.07	.04	.04	.23	.32	....	....	....	....	....
(Sancha)..........	96.04	3.11	.42	....	....	....	....	....	....	....	.57	....
"	95.82	3.18	.35	tr.	....	.24	....	....	....	....	....	....

acteristically in the hexahedrites in the form of rhabdite, and often constitutes 1½ to 3 per cent of their mass. Another characteristic mineral of the hexahedrites is daubreelite. Graphite and troilite are rare, although the latter mineral occurs in some members of the group in visible nodules. The hexahedrites may be divided into normal and brecciated hexahedrites, according to whether they are one or several individuals.

A. NORMAL HEXAHEDRITES.

In these hexahedrites the cleavage planes and Neumann lines run without change of direction throughout the mass.

HEXAHEDRITES.

Loss	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	......	98.24	7.-7.17	C. U. Shepard	1869, A. J. S. (2), XLVII, 230-233
....	......	100.77	....	O. Hildebrand......	1905, Meteoritenkunde, III, 217
....	......	100.00	7.782	Duflos & Fischer....	1847, Ann. Phy. Chem., LXXII, 475-480
.....	.02	100.30	7.8516	R. Knauer..........	1905, Meteoritenkunde, III, 207
....	......	101.39	7.8678	E. Cohen...........	1894, Meteoreisen-Studien A. N. H., IX, 104
....	......	100.00	7.825	C. U. Shepard	1867, A. J. S. (2), XLIII, 385
....	......	100.07	7.692	J. L. Smith	1869, A. J. S. (2), XLVII, 385
....	......	100.22	....	O. Bürger..........	1905, Meteoritenkunde, III, 194
....	......	100.935	....	H. Wichelhaus......	1863, Ann. Phy. Chem., CXVIII, 631-634
....	......	100.05	....	N. F. Lupton.......	1885, A. J. S. (3), XXIX, 233
....	......	100.01	....	J. E. Whitfield......	1899, A. J. S. (4), VIII, 154
....	......	100.37	....	R. Knauer..........	1905, Meteoritenkunde, III, 213
....	......	100.50	....	Hildebrand & Cohen	Same
....	......	100.46	....	Knauer & Cohen....	Same
....	......	100.00	7.522	J. B. Mackintosh....	1886, A. J. S. (3), XXXII, 306
....	......	99.92	7.699	Meunier............	1887, C. R., CIV, 872-873
....	......	98.93	7.72	"	1893, B. S. H. N., VI, 17
....	......	100.26	....	E. Cohen...........	1889, Neues Jahrb., 227
.....	.02	101.19	7.84	O. Hildebrand.....	1905, Meteoritenkunde, III, 194
....	......	100.14	8.13	F. A. Genth........	1854, A. J. S. (2), XVII, 239-240
....	......	99.59	7.81	J. L. Smith..........	1855, A. J. S. (2), XIX, 160-161

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Hex River........	93.33	5.58	.84	....	....	......	......	....	....	....	...	....
" "	93.59	5.68	.66	.04	.02	.23	.08	....	....	....	.03	....
Iredell............	93.75	5.51	.52	....	....	.20	.06	....	....	....	....	....
Lick Creek........	93.00	5.74	.52	tr.	....	.36	tr.	....	....	tr.	....	....
Murphy...........	93.93	5.52	.61	.02	....	.34	......	.04	....	.06	....	....
Scottsville	94.32	5.01	tr.	....	....	.16	.34	.12	....	....	....	....
"	93.14	5.73	.99	.10	....	.15	......	....	....	....	.02	....
"	94.03	5.33	.95	.04	.02	.23	.07	....	....	....	.01	....
Walker County....	94.14	5.30	.64	.06	.05	.28	.19	....	....	....	....	....

B. BRECCIATED HEXAHEDRITES.

These hexahedrites are characterized by a structure which gives them the appearance of being aggregates of individual grains. Not only do apparent outlines of grains occur, but the directions of the Neumann lines are different on the different grains. The size of the grains differs in different falls, but is fairly uniform for meteorites of the same fall. The contour of the grains may be rounded, polygonal, elongated, or ragged, and as a rule the grains are sharply separated from one another. When the divisions between grains widen to a cleft, some accessory constituent usually occupies the gap. Accessory minerals are not, however, abundant. The presence of dau-

BRECCIATED

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Bingera...........	93.76	4.39	.57	....	....	.23	......	.14	....	....	.54	Na. tr.
"	93.50	5.54	.51	.01	....	.26	......	.03	.01	....	....	Sn. .02 Mn. Pt. Ir. tr.
Holland's Store....	93.06	5.35	1.00	....	.23	.31	.08	....	....	....	.08	....
" ...	94.60	4.97	.21	....	....	.21	tr.	tr.	....	....	....	....
Indian Valley......	93.59	5.56	.53	tr.	....	.27	.01	....	tr.	....	....	....
Kendall County...	92.65	5.64	.78	.03	.01	.34	.03	1.62	....	.01	....	....
Mount Joy	93.80	4.81	.51	.005	....	.19	.01	....	....	....	....	....
Summit...........	93.39	5.62	.58	....	....	.31	......	....	....	....	....	....

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	.94	100.69	....	Cohen & Weinschenk	1891, Meteoreisen-Studien A. N. H., VI, 143
....	......	100.43	7.8225	R. Knauer..........	1905, Meteoritenkunde, III, 225
....	......	100.04	....	J. E. Whitfield......	1899, A. J. S. (4), VIII, 415-416
....	......	99.62	....	Smith & Mackintosh	1880, A. J. S. (3), XX, 324-326
....	......	100.52	7.7642	J. Fahrenhorst	1900, Meteoreisen-Studien A.N.H., XV, 368
....	......	99.95	7.848	J. E. Whitfield......	1887, A. J. S. (3), XXXIII, 500
....	......	100.13	....	Fischer............	1889, Neues Jahrb., I, 227
....	......	100.68	7.7959	R. Knauer..........	1905, Meteoritenkunde, III, 220
....	......	100.66	7.7806	O. Hildebrand......	1905, Meteoritenkunde, III, 173

breelite has not been noted, and schreibersite is not common, either in nodules or as rhabdite. The view that the brecciated hexahedrites are aggregates is not accepted by Brezina, except in the case of Kendall County. He regards the structure and cleavage of the other members of the division as uniform, and explains the varying orientation as caused by twinning. Mount Joy, placed by Berwerth, Cohen, and Brezina among the coarsest octahedrites, because of an apparent octahedral structure observed by Berwerth, seems to the present writer to belong more properly to the hexahedrites. In composition and structure it agrees fully with the hexahedrites, and it shows no trace of cohenite, a characteristic mineral of the coarse octahedrites. Its individual grains are the largest of any of the following group:

HEXAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	......	99.63	7.834-7.849	A. Liversidge.......	1882, Proc. Roy. Soc. N. S. W., XVI, 31-34
....	......	99.88	7.761	J. C. H. Mingaye.....	1904, Rec. Geol. Sur. N. S. W., VII, 308-310
....	......	100.11	....	Zaubitzer	1905, Meteoritenkunde, III, 240
....	......	99.99	7.801	J. E. Whitfield......	1887, A. J. S. (3), XXXIV, 472
....	......	99.96	7.95	L. G. Eakins........	1892, A. J. S. (3), XLIII, 424
....	......	101.11	....	Scherer	1900, Meteoreisen-Studien, A. N. H., XV, 387
....	......	99.33	....	L. G. Eakins........	1892, A. J. S. (3), XLIV, 416
....	......	99.90	6.949	F. P. Venable.......	1890, A. J. S. (3), XL, 322

II. OCTAHEDRITES.

The meteorites of this class are the most abundant among iron meteorites. According to the width of the lamellæ as seen in etched sections, they are divided as follows: Coarsest octahedrites, lamellæ, many mm. to 2.5 mm. in width; coarse octahedrites, lamellæ 2–1.5 mm. in width; medium octahedrites, lamellæ 1.0–0.5 mm. in width; fine octahedrites, lamellæ 0.4–0.2 mm. in width; finest octahedrites, lamellæ from 0.2 mm. down. While no sharp line of separation can be drawn between these groups, the members of each group present as a rule characters more or less peculiar to themselves. As compared with the hexahedrites, the octahedrites differ in structure in being made up of lamellæ arranged in accordance with the planes of the octahedron. These lamellæ in turn are composed of two or more alloys of nickel-iron. In composition a higher percentage of nickel-cobalt may be noted among the octahedrites, as compared with the hexahedrites, and schreibersite and troilite are far more abundant than in the hexahedrites. Cohenite, which is not known to occur in the hexahedrites, is characteristic of certain groups of the octahe-

COARSEST

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Arispe	92.27	7.04	....	....	....	.....	.....	....	....	....	....	....
Canyon Diablo....	95.370	3.945	....	....	....	.144	tr	....	tr.	....	.26	....
" "	91.396	7.94	....	....	....	.179	.004	.417	.047	....	....	....
Canton	91.96	6.70	.50	.03	....	.11	.01	....	tr.	....	....	....
Central Missouri...	94.73	4.62	.18	....	....	.44	.02	.01	....	....	....	....
Nelson County....	93.10	6.11	.41	tr.	....	.05	.....	....	....	....	....	....
Pittsburg..........	92.81	4.66	.39	.03	....	.25	.04	....	....	....	....	Mn...... .14
"	93.38	5.89	1.24	.05	.02	.15	.07	....	....	....	....	Chromite. .07
Ponca Creek......	91.74	6.53	....	....	....	.01	.....	....	....	....	....	Sn....... .06
" "	91.74	7.08	....	....	....	.01	.....	....	....	....	....	Sn....... .06
São Julião.........	89.39	8.27		tr.	....	.26	.....	....	....	....	....	....
Seeläsgen.........	90.00	5.31	.43	.10	....	.....	.....	....	1.16	....	.83	Mn...... .91
"	92.33	6.23	.67	....	....	.....	.....	.52	.02	....	.18	Cu.+Sn.. .05

drites, while graphite and diamond are also largely confined to the octahedrites. Daubreelite and chromite, which are common constituents of the hexahedrites, are rare in the octahedrites. The nickel-cobalt content of the octahedrites varies from 5½ to 15½ per cent.

A. NORMAL OCTAHEDRITES.

In the normal octahedrites the lamellar structure extends without change of direction, except for occasional curving, through the individual. This is true even for large masses like those of Charcas, Chupaderos, and Willamette.

1. COARSEST OCTAHEDRITES.

Width of lamellæ from many millimeters down to 2.5 mm. The nickel-cobalt content is as a rule slightly higher than in the hexahedrites, reaching in some cases 7 per cent. The presence of cohenite and graphite is characteristic of the group. Canyon Diablo contains diamond. The octahedral structure and presence of lamellæ is often difficult to discern, so that some members of the group have been classed as hexahedrites.

)CTAHEDRITES.

..oss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	......	99.31	7.853	J. E. Whitfield......	1902, Proc. Roch. Acad. Sci., IV, 85
....	......	99.719	7.703	H. Moissan.........	1904, Comptes Rendus, CXXXIX, 776
....	......	99.983	....	Booth, Garrett & Blair	1905, Proc. Phil. Aca. Sci., LVII, 875
....	......	99.31	....	H. N. Stokes........	1895, A. J. S. (3), L, 252-4
....	......	100.00	....	Mariner & Hoskins..	1900, A. J. S. (4), IX, 286
....	......	99.67	....	J. L. Smith..........	1860, A. J. S. (2), XXX, 240
....	......	98.32	7.74	F. A. Genth.........	1876, A. J. S. (3), XII, 72-73
....	......	100.87	....	O. Hildebrand	1903, Mitt. f. Neu Vorp. u. Rügen, XXXV, 4
....	......	98.34	7.952	C. T. Jackson.......	1863, A. J. S. (2), XXXVI, 261
....	......	98.89	7.952	" "	1863, A. J. S. (2), XXXVI, 261
....	......	97.92	7.783	C. v. Bonhorst	1888, Neues Jahrb., 372
....	......	98.74	7.63 – 7.71	A. Duflos...........	1848, Ann. Phy. Chem., LXXIV, 61-65
....	......	100.00	7.73	C. Rammelsberg....	1848, Ann. Phy. Chem., LXXIV, 443-448

2. COARSE OCTAHEDRITES.

Width of lamellæ 2.0–1.5 mm. The lamellar or octahedral struc-

COARSE

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Beaconsfield	92.56	7.34	.48	.02		.26	.04	.05		.01		
Bendego	91.90	5.71									.46	
"	88.46	8.59						.07				P. Fe. Ni. .37
Billings	91.99	7.38	.42	.01		.15	.06		.08			
Bischtübe	93.39	6.48	.87	.03	tr.	.05					.01	
Black Mountain	96.04	2.52									1.44	
Bohumilitz	94.06	4.01					.81					C. etc. 1.12
" ⅔	93.12	4.74	.23								1.91	
"	94.77	3.81	.20								2.20	
Canyon City	88.81	7.28	.17			.12						
" "	91.25	7.85	.17			.10						
Cosby Creek	87.00	12.00						.50				
" " ⅔	93.91	4.55									.10	
" "	91.64	5.85	.81	*.22		.19			.08			Mn. .09 Graphite .80
" "	91.90	6.70	.33			.09			.18			
" "	92.75	6.91	.51	.02		.37						
Duell Hill	94.24	5.17	.37	tr.		.14					.15	
Greenbrier County	91.59	7.11	.60	tr.		.08						
Jennie's Creek	91.56	†8.31				.13						
Lexington County	92.42	6.08	.93			tr.					.26	Sn. tr.
Magura ⅔	93.62	5.68										
"	89.42	8.61										C. Cu. Si. Sch. 1.41
" ⅔	90.91	7.32										Co. C. Si., etc., 1.17
"	92.55	7.08	.51	.02		.24	.02	.03		.01		
Niagara	92.67	7.37	.13									
Oscuro Mountains	90.79	7.66	.57			.27		.07				

*Cu. Sn. †By diff.

ture is more obvious than in the coarsest octahedrites, and the nickel-cobalt content in some members slightly higher. Cohenite and graphite are characteristic and common ingredients.

OCTAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	......	100.76	....	O. Sjöström.........	1897, Sitzber. Berl. Akad., 1047
.93	......	100.00	7.73	Flickentscher.......	1863, Buchner, Meteorites, 144
.96	......	99.45	7.47	Wohler & Martius..	1867, Phipson, Meteorites, 94
....	......	100.09	....	H. W. Nichols......	1905, A. J. S. (4), XIX, 242
....	......	100.82	....	Scherer & Sjöstrom.	1897, Meteoreisen-Studien, V, A.N.H., XII, 55
....	......	100.00	7.261	C. U. Shepard......	1847, A. J. S. (2), IV, 81–83
....	.....	100.00	7.15	J. Steinman.........	1830, A. J. S. (1), XIX, 384–386
....	......	100.00	....	J. J. Berzelius.......	1833, Ann. Phy. Chem., XXVII, 118–132
....	......	100.98	....	"	1853, A. J. S. (2), XV, 12
....	......	96.38	7.1	C. U. Shepard......	1885, A. J. S. (3), XXIX, 469
....	......	99.37	7.68	J. M. Davison.......	1904, A J. S. (4), XVII, 383
.50	......	100.00	....	G. Troost...........	1840, A. J. S. (1), XXXVIII, 254
....	......	98.56	6.22	C. U. Shepard.......	1842, A. J. S. (1), XLIII, 354–357
....	......	99.68	....	C. A. Joy...........	1853, Ann. Chem. Pharm., LXXXVI, 39–43
....	......	99.20	7.26	C. Bergmann.......	1857, Ann. Phy. Chem., C, 254–255
....	......	100.56	....	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A.N.H. XV, 373
....	......	100.07	7.46	B. S. Burton........	1876, A. J. S. (3), XII, 439
....	.12	99.50	....	L. Fletcher.........	1887, Min. Mag., VII, 183
....	......	100.00	7.344	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 147
....	......	99.69	7.00–7.405	C. U. Shepard, Jr ...	1881, A. J. S. (3), XXI, 119
....	......	99.30	7.814	A. Patera...........	1847, Östr. Blätt. f. Lit., No. 169,–670
....	......	99.44	7.814	"	Same
....	......	99.30	7.01–7.22	A. Löwe............	1849, Neues Jahrb., 199
....	......	100.46	....	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A.N.H. XV, 378
....	......	100.07	7.12	J. M. Davison.......	1902, Jour. Geol., X, 518-519
....	......	99.36	....	R. C. Hills.........	1897, Proc. Colorado Sci. Soc.

Name.	Fe.	Ni.	Co.	Cu	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
St. Francois County	92.10	2.60	tr.	....	....	tr.	......	tr.	tr.	.....	....	Schreibersite ..5.0
" " "	92.68	6.97	.52	.02	....	.34	.01	.....	.....	.03	.01	....
Sarepta...........	95.94	2.66	.....	....	....	......	......	.....	.02	.....	....	Sn.02 P.Fe.Ni. 1.32
Silver Crown......	91.57	8.31	tr.	....	....	.07	......	tr.	.....	.....	....	....
Smithville.........	91.57	7.02	.62	tr.	....	.18	......	.....	.....	.....	....	Res. Mainly Carb. .15
Tabarz............	92.76	5.69	.79	....	....	.86	......	.....	.....	.....	....	P. Fe. Ni. .28
Wichita...........	89.99	10.01	tr.	....	....	......	......	.....	.....	.....	....	....
Willamette........	91.46	8.30	.....	....	....	......	......	.....	.....	.....	....	....
"	91.65	7.88	.21	....	....	.09	......	.....	.....	.....	....	....
Youndegin........	92.67	6.46	.55	tr.	....	.24	......	.....	.....	.....	.04	Mg....... .42

3. MEDIUM OCTAHEDRITES.

Width of lamellæ 1.0-0.5 mm. More than one-third of the iron meteorites belong to this class. They present, as a rule, quite uniform characters. The lamellar structure is, as a rule, well-defined, and

MEDIUM

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Abert Iron........	92.92	6.07	.54	....	....	......	......	.....	.....	.....	....	Schreibersite. .56
"	92.04	7.00	.68	....	....	.08	.01	.02	.....	.....	....	Graphite. .03
Algoma	88.62	10.63	.84	....	....	.15	tr.	.....	.02	.....	....	....
Angara...........	92.64	7.10	.....	....	....	.16	......	tr.	.04	.....	tr.	Ca. tr. Mg. .06
Arlington.........	90.78	8.60	1.02	tr.	tr.	.05	......	tr.	.....	.....	....	....
Asheville	96.50	2.60	.....	....	....	......	......	.....	.50	.20	....	....
Bald Eagle	91.36	7.56	.70	....	....	.09	.06	.....	tr.	.....	....	....
Burlington........	92.29	8.14	.....	....	....	......	......	.....	.....	.....	....	....
"	95.20	2.13	.....	....	....	......	......	.....	.....	.....	.50	S. & loss. 2.17
"	89.75	8.90	.62	tr.	....	......	......	.....	.....	.....	.70	Mn. tr.
Cabin Creek......	91.87	6.60	tr.	....	....	.41	.05	Comb'nd .15	.....	tr.	.34	....
Cachiyuyal	93.92	4.93	.39	....	....	.08	......	.....	.20	.....	....	Ca. Mg... .30

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....	......	99.70	7.02–7.11	C. U. Shepard	1869, A. J. S. (2), XLVII, 233 234
.....	......	100.58	7.746	J. Fahrenhorst	1900, Meteoreisen-Studien,XI, A.N.H. XV,371
.....	......	99.96	....	J. Auerbach.........	1864, Sitz. Wien Akad., XLIX (2), 497
.....	......	99.95	7.63	H. L. McIlwain.....	1888, A. J. S. (3), XXXVI, 277
.....	......	99.54	....	O. W. Huntington...	1894, Proc. Am. Acad. Arts & Sci., XXIX, 253
.....	......	100.38	7.74	W. Eberhard.......	1855, Ann. Chem. Pharm., XCVI, 286-289
.....	......	100.00	....	W. P. Riddell.......	1860, Trans. St. Louis Acad. (1), 623
.....	......	99.76	....	J. E. Whitfield......	1904, Proc. Rochester Acad. Sci., IV, 148
.....	......	99.83	7.7	J. M. Davison.......	Same
.....	......	100.38	....	L. Fletcher.........	1887, Min. Mag., VII, 125

the three alloys—kamacite, taenite, and plessite—are usually present. Among accessory constituents, troilite and schreibersite predominate. These are often in the form of nodules of appreciable size.

OCTAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....	......	100.09	7.589	C. U. Shepard, Jr....	1876, A. J. S. (3), XII, 119
.....	......	99.86	7.89	R. B. Riggs	1887, Bull. U. S. Geol. Sur. VIII, 94 97
.....	......	100.26	7.75	A. A. Koch	1903, Bull. Geol. Soc. Amer. XIV, 104
.....	......	100.00	....	M. A. Gobel	1874, Bull. St. Petersburg Akad. XIX, 544–54
.....	......	100.45	....	F. F. Sharpless	1896, Amer. Geol. XVIII, 270
.....	......	99.80	6.50–7.50	C. U. Shepard	1839, A. J. S. (1), XXXVI, 81-84
.....	......	99.77	7.06	W. G. Owens.......	1892, A. J. S. (3), XLIII, 423–424
.....	......	100.43	....	C. H. Rockwell	1844, A. J. S. (1), XLVI, 402
.....	......	100.00	....	C. U. Shepard......	1847, A. J. S. (2), IV, 77–78
.....	......	99.97	7.72	W. S. Clark	1852, Metallic Meteorites, 61–62
.....	......	99.42	7.837	J. E. Whitfield......	1887, A. J. S. (3), XXXIII, 500
.....	......	99.82	....	J. Domeyko	1875, Comptes Rendus, LXXXI, 597

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	Insol.	Miscellaneous.
Caperr	89.87	9.33	.53	tr.	tr.	.24						
Cape York	90.14	8.18	.54			.18	.19	.15				
" 3/3	91.31	7.94	.53	.02		.19	.01	.04				
Carthage	89.47	7.72	.25			.09	.40		.60	tr.		1.19
Casas Grandes	95.13	4.38	.27	tr.		.24		tr.				
"	92.66	7.26	.94		.03	.18	.02					Chromite ..03
Chilkoot	92.56	7.11	.12	tr.		.12	.04	tr.				
Chulafinnee	91.61	7.37	.50			.17						
Cleveland 3/3	89.59	8.79	.67	.12		.32	.006					
Colfax 2/2	88.45	10.31	.57	.04		.19	.09		.02			
"	88.05	10.37	.68	.04		.21	.08		.02			
Coopertown	89.59	9.12	.35	tr.		.04						
Costilla	91.65	7.71	.44			.10	High. .26					
Dalton	94.66	4.80	.34		tr.	tr.						Mn. tr.
Denton County	94.02	5.43	tr.								.33	
"	92.10	7.53	tr.			.001						
Descubridora	89.51	8.05	1.94				.45					P.Cr. and loss. .05
"	90.09	9.07 (Ni. and Co.)		.24							.66	
Elbogen	97.50	2.50										
"	87.50	8.75			tr.							Mn. tr.
"	88.23	8.52	1.85				tr.					P. Fe. Ni. 2.21 Mg.28, Mn.tr.
"	89.90	8.43	.76									
"	94.69	2.47	.61		.12							Al. 19, Mn. .88
El Capitan	90.51	8.40	1.59	.05		.24	tr.					
Fort Pierre	94.29	7.19	.60				tr.					Ca. .35, Mg. .65
"	90.76	7.61	.89	tr.		tr.					.05	
Franceville	91.10	8.06 (Ni. and Co.)							tr.			*Pt. tr.
Frankfort	90.58	8.53	.36	tr.		.05						
Glorieta	88.76	9.86	.51	.03		.18	.01		.04			Zn. .03, Mn.tr.

*Schreibersite, .84; Graphite, tr.; Silicate, tr.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	......	99.97	7.86	L. Fletcher.........	1899, Min. Mag. XII, 167–170
....	......	99.38	....	J. K. Phelps	1898, Northward Over the Great Ice, (2) 600
....	......	100.04	....	J. E. Whitfield.....	" " " " 602
....	......	99.72	7.48–7.50	E. Boricky	1866, Neues Jahrb, 808–810
....	......	100.02	....	W. Tassin..........	1902, Proc. U. S. Nat. Mus. XXV, 71
....	......	101.12	7.885	Cohen & Hildebrand	1903, Mitt. Nat. Ver. f. Neuvorp. u. Rügen, XXXV, 13
.05	......	100.00	7.76	....	1905, Label, State Mining Bureau Collection, San Francisco, California
....	......	99.65	....	J. B. Mackintosh....	1880, A. J. S. (3), XX, 74
....	......	99.496	7.521	F. A. Genth	1886, Proc. Phila. Acad. Sci. 366–368
....	......	99.67	....	S. W. Cramer	1890, Trans. N. Y. Acad. Sci. IX, 197–198
....	......	99.45	....	L. G. Eakins	1890, A. J. S. (3), XXXIX, 395–396
....	......	99.10	7.85	J. L. Smith	1861, A. J. S. (2) XXXI, 266
....	......	100.16	....	L. G. Eakins	1895, Proc. Colo. Sci. Soc.
....	......	99.80	7.986	C. U. Shepard, Jr...	1883, A. J. S. (3), XXVI, 338
....	......	99.78	7.67	W. P. Riddell.......	1860, Trans. St. Louis Acad. I, 623
....	......	99.63	7.42	A. Madelung.......	1863, Buchner, Meteoriten, 193
....	......	100.00	7.38	P. Murphy	1875, Neues Jahrb, 26
....	......	100.00	7.609	J. B. Mackintosh....	1887, A. J. S. (3), XXXIII, 235
....	......	100.00	7.80–7.83	M. H. Klaproth.....	1815, Beit. Mineralkörper, VI, 306–308
....	......	98.10	7.76	J. F. John	1821, Jour. Chem. Phys. XXXII, 253–261
....	......	100.00	7.74–7.87	J. J. Berzelius.......	1834, Ann. Phys. Chem. XXXIII, 135–137
.06	......	99.00	7.78	A. Wehrle	1863, Buchner, Meteoriten, 151–152
....	......	99.94	....	P. A. v. Holger	" " " "
....	......	99.80	....	H. N. Stokes	1895, A. J. S. (3), I, 252–254
....	......	102.48	7.73	H. A. Prout.........	1860, Trans. St. Louis Acad. I, 711–712
....	......	99.31	7.74	A. Madelung	1863, Buchner, Meteoriten, 197
....	......	100.00	7.87	J. M. Davison	1902, Proc. Roch. Aca. Sci. IV, 75–78
....	......	99.52	7.69	J. L. Smith	1870, A. J. S. (2), XLIX, 331
....	......	99.42	....	L. G. Eakins	1885, Proc. Colo. Sci. Soc. II, 14

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Glorieta	88.81	7.28	.17	....	....	.12	.....	....	....	....	...	....
"	87.93	11.15	33	....	....	.36	.....	....	....	....	...	....
Guilford County ..	92.75	3.15	tr.	....	....	.....	.....	....	....	....	...	$Fe_2O_3 + FeO$ .75
Hopewell Mounds.	95.20	4.64	.40	.04	....	.07	.13	....	....	....	...	Mn. tr., Sn. tr.
Hopper	90.54	7.70	.94	....	....	.13	.....	....	.04	.35	...	....
Hraschina	96.50	3.50	.....	....	....	.....	.....	....	....	....	...	....
"	83.29	11.84	1.26	....	....	.....	.....	....	.68	...	...	Mn. .64, Mg. .48 K. .43, Al. 1.38
"	89.78	8.88	.67	....	....	.....	.....	....	....	....	...	....
Ivanpah	94.98	4.52	.....	....	....	.07	.....	.10	....	....	...	....
Joel's Iron	90.45	8.80	.54	tr.	....	.26	.....	tr.	....	....	...	....
Joe Wright	91.22	8.62*		....	....	.16	.....	....	....	....	...	....
Juncal	92.03	7.00	.62	....	....	.21	.....	....	....	....	...	....
Kenton County....	91.59	7.65	.84	tr.	....	tr.	tr.	.12	....	....	...	....
Kokstad	91.21	8.01	.63	.02	....	.22	tr.	.03	....	.05	...	....
La Caille .... ⅔	92.50	5.90	tr.	....	tr.	.....	.....	....	.90	....	...	....
" .... ⅔	89.63	9.83	.....	....	....	.....	.....	.12	....	....	...	Insol. & loss. .42
Lenarto	85.04	8.12	3.59	....	....	.....	.....	....	.01	....	...	Ca. 1.63, Al. .77 Mn. .61, Mg. .23.
"	90.90	8.50	.665	.002	....	.....	.....	....	....	....	...	....
"	90.15	6.55	.50	.08	....	.....	.48	....	....	....	1.23	Mn .15, Sn .08
"	90.88	8.45	.67	....	....	.....	.....	....	....	....	...	....
"	91.50	8.58	.....	tr.	....	.....	.....	....	....	....	.30	....
Losttown	95.76	3.66	tr.	....	tr.	.....	.....	....	....	....	.58	Ca. tr.
Luis Lopez	91.31	8.17	.16	....	....	.33	.01	.01	tr.	....	...	....
Marshall County ..	90.12	8.72	.32	tr.	....	.10	.....	....	....	....	...	....
Matatiela	92.20	7.30	.67	.03	....	.19	.03	.08	....	.03	...	....
Mazapil	91.26	7.84	.65	....	....	.30	.....	....	....	....	...	....
Merceditas	92.38	7.33	.61	.02	....	.08	.07	....	....	....	.02	....
Misteca...........	86.86	9.92	.74	....	....	.07	.55	....	....	....	.97	....
Morito	95.01	4.22	.51	tr.	....	.08	....	....	....	....	...	....

By diff.

...ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	96.38	7.1	C. U. Shepard	1885, A. J. S. (3), XXIX, 469
..	......	99.77	7.66	J. B. Mackintosh....	1885, A. J. S. (3), XXX, 238
..	......	96.65	7.67	C. U. Shepard	1841, A. J. S. (1), XL, 369 370
..	......	100.48	....	H. W. Nichols......	1902, Field Col. Mus. Pub. Geol. Ser. I, 308
..	......	99.70	....	F. P. Venable	1890, A. J. S. (3), XL, 163
..	......	100.00	7.73-7.80	M. H. Klaproth.....	1807, Beit. Mineralkörper, IV, 99-101
..	......	100.00	7.82	P. A. v. Holger	1830, Beit. u. vor. Ett. Zeit. f. Phys. u. Math. VII, 2, 129-149
..	......	99.33	7.785	A. Wehrle	1852, Clark, Metallic Meteorites, 42-44
..	......	99.67	7.65	C. U. Shepard	1880, A. J. S. (3), XIX. 381-382
..	......	100.05	7.863-7.958	L. Fletcher.........	1889, Min. Mag. VIII, 264
..	......	100.00	....	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 462
..	......	99.86	....	A. A. Damour	1868, Comptes Rendus, LXVI, 569-571
..	......	100.20	....	J. M. Davison	1892, A. J. S. (3), XLIV, 164
..	......	100.17	7.7876	Fahrenhorst........	1900, Ann. S. Afr. Mus. II, 14
..	......	99.30	7.43	L. E. Rivot	1854, Ann. Mines (5), VI, 554-555
..	......	100.00	7.64	J. Boussingault	1872, Comptes Rendus, LXXIV, 1287-1289
..	......	100.00	....	P. A. v. Holger	1830, Beit. u. Ett. Zeit, f. Phys. u. Math. VII, 2, 129-149
..	......	100.067	7.79	A. Wehrle	1841, Rammelsberg, Handworterbuch, 423
..	......	99.22	7.73	W. S. Clark	1852, Metallic Meteorites, 40
..	......	100.00	7.98	A. Wehrle	" " " "
..	......	100.38	7.73	J. Boussingault	1872, Comptes Rendus, LXXIV, 1288-1289
..	......	100.00	....	C. U. Shepard	1869, A. J. S. (2), XLVII, 234
..	......	99.99	....	Mariner & Hoskins .	1900, A. J. S. (4), IX, 284
..	......	99.26	....	J. L. Smith.........	1860, A. J. S. (2), XXX, 240
..	......	100.53	7.8084	J. Fahrenhorst......	1900, Ann. So. Afr. Mus. II, 17
..	......	100.05	....	J. B. Mackintosh....	1887, A. J. S. (3), XXXIII, 225.
..	......	100.51	....	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H. XV, 380
..	......	99.11	7.58	C. Bergeman	1857, Pogg. Ann. C. 246
..	......	99.82	7.84	J. L. Smith	1871, A. J. S. (3), II, 335-338

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	Insol.	Miscellaneous
Murfreesboro	96.00	2.40	....	....	....	......	......	....	....	....	....	....
Nejed	91.04	7.40	.66	tr.	....	.10	tr.	....	....	....	....	....
Orange River.....	90.48	8.94		....	tr.	......	......	....	....	....	....	Chladnite .5 Schreib. . .0
Petropawlowsk....	97.29	2.07	....	....	....	......	......	....	....	....	....	....
" ....⅔	93.57	6.98	....	....	....	......	......	....	....	....	....	....
Plymouth.........	88.67	8.55	.66	.24	....	1.25	.07	....	....	....	....	Graph. .. .1
Puquios	88.67	9.83	.71	.04	....	.17	.09	.04	tr.	....	....	....
Red River	90.02	9.67	....	....	....	......	......	....	....	....	....	....
"	90.91	8.46	....	....	....	......	......	....	....	....	.50	....
Rhine Valley	88.85	9.07	.34	....	....	.27	.75	....	....	....	....	....
Roebourne	90.91	8.33	.06	....	....	.16	tr.	tr.	.01	....	....	Mn. tr.
Rowton	91.05	9.08		tr.	....	......	......	....	....	....	....	....
"	91.25	8.58	.37	tr.	....	......	......	....	....	....	....	....
Ruff's Mountain...	96.00	3.12	....	....	....	......	......	....	....	....	....	....
"	90.95	6.01	tr.	....	tr.	......	......	....	....	....	2.35	Schreib... .5
Sacramento Mts...	91.39	7.86	.52	....	....	......	......	....	....	....	....	....
San Angelo.......	91.96	7.86	tr.	.04	....	.10	.03	tr.	.01	....	....	Mn. tr.
Schwetz	93.18	5.77	1.05	....	....	......	......	....	....	....	.10	....
Seneca Falls......	92.40	7.60	....	....	tr.	tr.	fr.	....	....	....	....	Mg. tr. Mn. ? Sn. tr
Staunton	91.44	7.56	.61	.02	....	.07	.02	.14	.11	tr.	....	Sn. tr.
"	90.29	8.85	.49	.02	tr.	.24	.01	.18	.09	tr.	....	Sn...... .00 Mn. tr.
" No. 1...	88.71	10.16	.40	.003	. ..	.34	.02	.17	.07	.003	....	Sn..... .00 Mn. tr.
" No. 2...	88.36	10.24	.43	.003	....	.36	.008	.18	.06	.002	....	Sn...... .00
" No. 3...	89.01	9.96	.39	.003	....	.37	.03	.12	.06	.004	....	Sn...... .00 Mn. tr.
" No. 7...	89.85	7.56	.60	.06	....	.16	.01	.05	.05	.....	....	O....... 1.5
Surprise Springs ..	91.01	7.65	.89	.07	.04	.22	.08	.02	.....	.02	....	....
Thunda	91.54	8.49	.56	.02	tr.	.17	.02	....	....	....	.01	....
Toluca	91.38	8.62	....	....	....	......	......	....	....	....	....	....
"	90.40	5.02	.04	....	....	.16	......	....	....	....	....	P. Fe. Ni. 2.9 Mn. tr.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.	1.60	100.00	....	G. Troost	1848, A. J. S. (2), V, 351–352
.	.59	99.79	7.89	L. Fletcher.........	1887, Min. Mag. VII, 179–182
.	......	100.00	7.3	C. U. Shepard	1856, A. J. S. (2), XXI, 213
.	......	99.36	7.76	Sokolowsky	1841, Arch. Kunde Russ. I, 317
.	......	100.55	....	Iwanow	1841, Arch. Kunde Russ. I, 723-725
.	......	99.55	....	J. M. Davison.......	1895, A. J. S. (3), XLIX, 53-55
.	......	99.55	7.93	L. G. Eakins	1890, A. J. S. (3), XL, 226
.	......	100.00	7.54	C. U. Shepard	1829, A. J. S. (1), XVI, 217–219
.	......	99.87	7.40–7.82	B. Silliman, Jr. & T. S. Hunt.	1846, A. J. S. (2), II, 372–374
.	......	99.31	....	W. S. Chapman	1900, Ann. Rep. So. Aust. Sch. Mines, 227-228
.	......	100.00	....	Mariner & Hoskins .	1898, A. J. S. (4), V, 136
.	......	100.13	....	W. Flight	1882, Phil. Trans. 894-896
.	......	100.20	....	"	" " "
.	......	99.121	7.01–7.10	C. U. Shepard	1850, Proc. A. A. A. S. III, 152-154
.	......	99.81	....	Boecking	1856, Neues Jahrbuch, 51
.	......	100.00	7.7	Mariner & Hoskins .	1898, A. J. S. (4), V, 272
.	......	99.77	....	J. E. Whitfield......	1897, A. J. S. (4), III, 66
.	......	100.10	7.77	C. Rammelsberg....	1851, Ann. Phys. Chem. LXXXIV, 153–154
.	......	100.00	....	C. U. Shepard	1853, A. J. S. (2), XV, 366
.	......	99.97	7.69	J. P. Santos.........	1878, A. J. S. (3), XV, 337–338
.	......	100.175	....	J. W. Mallet.........	1887, A. J. S. (3), XXXIII, 59
.	......	99.878	7.85	"	1871, A. J. S. (3), II, 13
.	......	99.345	7.86	"	" " "
.	......	99.95	7.84	"	" " "
.	......	99.90	....	J. E. Whitfield......	1903, A. J. S. (4), XV, 469-471
.	......	100.00	7.7308	E. Cohen...........	1900, Mitt. Nat. Ver. f. Neu Vorp. u. Rügen, 32
.	......	100.81	....	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A. N. H. XV, 382
.	......	100.00	7.72	Berthier............	1853, A. J. S. (3), XV, 20
.	......	99.72	....	E. Uricoechea	1854, Jour. Prakt. Chem. LXIII, 317–318

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Toluca	90.37	7.79									1.91	
"	90.72	8.49	.44			.18			.25			
"	87.88	8.86	.89			.86						Graph.. 1
"	87.89	9.06	1.07	tr.		.62						*C. Graph.
"	88.29	8.90	1.04			.78						
"	90.08	7.10					1.24					
"	90.43	7.62	.72			.15	.03					†Cu. & Sn.
"	87.09	9.80	.77	.01			.79				.02	Schreib..
"	89.07	7.29	.98	tr.			.85				.04	Mn. tr. Fe. S. tr.
"	90.13	7.24 (Ni. and Co.)				.38					.22	
"	91.89	6.32	1.58									Mn. tr.
(Los Reyes)	90.56	7.71	1.07	.14		.24	.03	.01	.01			Mn. tr.
Tonganoxie	91.18	7.93	.39	tr.		.10						
Toubil	95.18	3.38	.14			.05		.12	.08	.04		Mn. .09 As. Mg. .03 Ca.
Trenton	91.03	7.20	.53	tr.		.14					.45	
"	89.22	10.79	tr.			.69						
Victoria	91.33	8.83	.49									
Welland	91.17	8.54	.06				.07					
Werchne Udinsk	91.02	7.31	.70	.13		.07		.03				Mg..... Fe. Ni. P.
Wooster	93.61	6.01	.73	tr.		.13						Mn. tr.

*P. Fe. Ni., .34; Mn., .20; Sn., tr.
†Graph., etc., .34; P., Fe., Ni., .56.

Undet.	Total.	Sp. Gr.	Analyst.	Reference.
......	100.07	....	W. J. Taylor........	1856, Proc. Phil. Aca. Sci. VIII, 3
......	100.46	....	"	1856, A. J. S. (2), XXII, 374-376
......	98.73	....	E. Pugh............	1856, Ann. Chem. u. Pharm. XCVIII, 383-386
......	99.40	....	"	" " " "
......	99.00	....	"	" " " "
......	98.42	....	"	" " " "
......	99.88	....	"	" " " "
......	99.21	....	Boecking...........	Neues Jahrbuch, 304
......	99.20	....	"	" "
......	100.00	....	H. B. Nason........	1857, Jour. Prakt. Chem. LXXI, 123
......	99.79	....	C. H. L. v. Babo	1863, Buchner, Meteoriten, 141
......	99.85	....	H. W. Nichols......	1902, Pub. Field Col. Mus., Geol. Ser, I 308
......	99.60	7.45	E. H. S. Bailey	1891, A. J. S. (3), XLII, 386
......	99.34	....	J. Antipoff..........	1898, Bull. St. Petersburg Acad. Sci. V, 9, 91-103
......	99.35	7.82	J. L. Smith	1869, A. J. S. (2), XLVII, 271
......	100.70	7.33	G. Bode............	1869, Ann. Rep. Smith. Inst. 417-419
......	100.65	7.78	A. P. Coleman......	1887, Proc. and Trans. Roy. Soc. Can., IV, 97
......	99.84	7.87	J. M. Davison.......	1890, Proc. Roch. Acad. Sci. I, 87
......	99.41	....	H. Laspeyres.......	1895, Zeit. Kryst. XXIV, 494
......	100.48	7.90	J. L. Smith	1864, A. J. S. (2), XXXVIII, 385-386

4. FINE OCTAHEDRITES.

Width of lamellæ 0.4-0.2 mm. The nickel-cobalt content ranges between 8 and 10½ per cent. The fields are usually equal in amount to the lamellæ and contain minute shining flakes, probably of taenite.

a. PRAMBANA…

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Augustinowka	91.91	7.70	.25	....	....	....	....	....	....	....	....	....
Bella Roca........	91.48	7.92	.22	....	....	.21	.21	.06	....	....	....	....
"	89.68	9.78	.55	.02	tr.	.31	.05	....	....	....	....	....
Bethany (Mukerop) ..	91.07	8.18	.63	.03	.02	.06	.04	.01	....	....	....	....
" " .	92.29	7.77	.57	....	....	.06	....	....	....	....	....	Cu. C. Cr. Cl. S.
" " ..	90.96	8.19	.46	.04	....	.18	tr.	.02	....	.01	.01	....
" " ..	91.37	7.97	.50	.02	.04	.03	.02	.05	....	....	....	....
" (Lion River)..	93.30	6.70	....	....	....	tr.	tr.	....	....	....	....	K_2O tr. Sn.
" " ..	92.06	7.79	.69	.03	.01	.05	.10	....	....	....	....	....
Boogaldi	91.13	8.05	.48	.28	....	....	....	....	....	....	.04	....
Bridgewater	88.90	9.94	.76	.35	....	....	....	....	....	.02	....	....
Bückeberg........	90.95	8.01		....	....	.64	....	....	....	....	....	....
"	92.45	7.55	.83	.02	.01	.12	.01	.01	....	.02	....	....
Cambria 2/2	94.88	5.69	....	....	....	....	....	....	....	....	....	....
"	92.58	5.71	....	tr.	....	....	....	....	....	....	1.40	As. tr.
"	89.06	10.65	.08	.04	....	....	.17	....	....	....	....	....
Charlotte	91.15	8.01	.72	.06	....	....	....	....	....	....	....	....
Chupaderos.......	90.23	8.76	1.21	....	....	tr.	....	....	....	....	....	....
"	88.78	9.80	.81	.02	tr.	.13	.13	....	....	....	....	....
Cuernavaca.......	88.98	10.30	....	....	....	....	....	....	....	....	....	....
"	89.70	8.76	1.19	.05	....	.33	.12	....	....	....	....	....
Grand Rapids.....	94.54	3.82	.40	....	....	....	....	....	....	....	.12	....
"	88.71	10.69	....	.07	....	.26	.03	.06	....	....	....	Mg. ..... Graph. ..
Hassi Jekna.......	91.32	5.88	.81	tr.	....	....	tr.	....	....	....	1.04	....
Jamestown........	90.24	9.75	....	tr.	....	.05	....	....	....	....	....	....

Cohen divides the fine octahedrites into two groups, the Prambanan group and the Rodeo group. The Prambanan group includes the greater number. They have a fairly uniform composition. Accessory constituents are usually present, but not in large quantity.

OUP.

s.	Undet.	Total.	Sp. Gr.	Analyst.	References.
..	......	99.86	....	W. F. Alexejew	1893, Verh. Russ. Min. Ges. II, 30, 470
..	......	100.10	....	J. E. Whitfield......	1889, A. J. S. (3), XXXVII, 440
.	......	100.39	7.8244	Knauer	1905, Meteoritenkunde, III, 377
..	......	100.04	7.8408	J. Fahrenhorst......	1900, Ann. S. Afr. Mus. II, 28
.	......	100.79	7.8408	"	" " "
.	......	99.89	....	O. Hildebrand......	1902, Jb. d. Ver. f. Vaterl. Naturk. Würtemberg, LVIII, 292–306
.	......	100.00	7.783	Krupp Lab.........	1902, Jb. d. Ver. f. Vaterl. Naturk. Würtemberg, LVIII, 292–306
.	......	100.00	7.45	C. U. Shepard......	1853, A. J. S. (2), XV, 1–4
.	......	100.73	....	Sjöström & Fahrenhorst.	1897, Meteoreisen-Studien, V, A. N. H. XII, 43
.	......	99.98	7.85	A. Liversidge.......	1902, Jour. Roy. Soc. N. S. W. XXXVI, 341–359
.	......	99.97	6.617	F. P. Venable	1890, A. J. S. (3), XL, 312–313
.	......	99.60	7.12	Wohler & Wicke...	1863, Göttingen Nach. 364-367
.	......	101.01	....	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H. XV, 367
.	......	100.57	7.52	D. Olmsted, Jr......	1845, A. J. S. (1), XLVIII, 388–392
.	......	99.69	....	B. Silliman, Jr., & T. S. Hunt.	1846, A. J. S. (2), II, 374–376
.	......	100.00	....	C. Rammelsberg ...	1870, Ber. Berl. Akad. 444
.	......	99.94	7.717	J. L. Smith	1875, A. J. S. (3), X, 351
.	......	100.20	....	Cohen & Weinschenk	1891, Meteoreisen-Studien, VI, A. N. H. VI, 147–148
.	tr.	99.67	....	O. Bürger..........	1905, Meteoritenkunde, III, 354
.	......	99.28	7.725	J. E. Whitfield	1902, Proc. Roch. Aca. Sci. IV, 79–88
.	......	100.15	7.748	O. Hildebrand......	1902, Mitt. d. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIV, 2
.	......	98.88	....	F. W. Taylor.......	1884, A. J. S. (3), XXVIII, 300
.	......	99.91	7.87	R. B. Riggs	1885, A. J. S. (3), XXX, 3'2
.	......	99.05	7.67	S. Meunier.........	1892, Comptes Rendus, CXV, 531–533
.	......	100.04	....	O. W. Huntington ..	1890, Proc. Am. Acad. (2), XVII, 229–232

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Jewel Hill	91.12	7.82	.43	tr.	....	.08	......	....	....	....	...	....
Lagrange.........	91.21	7.81	.25	tr.	....	.05	......	....	....	....	...	....
"	91.92	7.61	.62	.01	.02	.03	.02	....	....	....	...	....
Mantos Blancos...	90.77	8.83	.55	tr.	....	.10	......	....	....	....	...	....
Moonbi...........	91.35	7.89	.56	tr.	tr.	.22	......	.07	.04	....	...	Sn. tr.
Prambanan	96.71	2.86	....	....	....	......	......	....	....	....	...	....
"	94.36	5.37	....	....	....	......	......	....	....	....	...	....
"	88.60	11.20	....	....	....	.20	......	.004	tr.	....	...	MgO. tr.
"	90.03	9.39	.97	....	....	.16	......	....	....	....	...	....
"	94.38	4.70	....	....	....	.53	......	....	....	....	...	....
Putnam County ...	89.52	8.82	tr.	....	....	......	......	....	....	....	...	Sn. P. S. M, Ca........1.
" ...	90.28	7.89	.79	.07	.17	.11	.25	....	....	....	...	....
Russel Gulch	90.61	7.84	.78	tr.	....	.02	......	....	....	....	...	....
"	90.65	7.87	.01	....	....	......	......	....	....	....	...	Insol.Si.Sch.Cr. Sn. .02
St. Genevieve. ...	91.58	7.98	.29	....	....	.20	tr.	....	.02	....	...	....
Smith's Mountain..	90.68	9.07 (Ni. and Co.)		.11	....	.14	......	....	....	....	...	....
" ..	90.88	8.02	.50	.03	....	.03	......	....	....	....	...	....
Thurlow	89.17	9.92	1.04	....	....	.25	.05	....	....	....	...	Cu. & Cr.,
Varas	91.28	8.00	.44	tr.	....	.05	......	....	....	....	...	....
Yanhuitlan	96.58	1.83	....	....	....	......	......	tr.	.01	....	...	CaO..... Al_2O_3 ...
"	91.87	7.36	.65	.02	.01	.09	.02	....	....	....	...	....

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	99.45	....	J. L. Smith.........	1860, A. J. S (2), XXX, 240
..	......	99.32	7.89	J. L. Smith.........	1861, A. J. S. (2), XXXI, 265-266
..	......	100.23	....	O. Bürger..........	1905, Meteoritenkunde, III, 358
..	......	100.25	7.904	L. Fletcher.........	1889, Min. Mag. VIII, 258
..	......	100.13	7.83	J. C. H. Mingaye ...	1893, Jour. Roy. Soc. N. S. W. XXVII, 82-83
..	......	99.57	7.48	M. Van der Boom Mesch ...	1866, Archives Neerl. I, 468
..	......	99.73	7.83	E. H. von Baumhauer	" " " "
..	......	100.004	....	Vlaanderen	1867, Nat. Tij. Ned. Ind., XXIX, 268-270
..	......	100.55	....	O. Sjöström	1897, Meteoreisen-Studien, A. N. H. XII, 42-62
..	......	99.61	....	De Jong	1904, Javabode, July 12, 5
..	......	100.00	7.69	C. U. Shepard	1854, A. J. S. (2), XVII, 331-332
..	......	99.56	....	Knauer & Bürger...	1905, Meteoritenkunde, III, 345
..	......	99.25	7.72	J. L. Smith.........	1866, A. J. S. (2), XLII, 218-219
..	......	99.50	7.692	C. T. Jackson	1867, A. J. S. (2), XLIII, 281
..	......	100.07	....	J. E. Whitfield......	1901, Proc. Roch. Acad. Sci. IV, 65-66
..	......	100.00	....	F. A. Genth........	1877, A. J. S. (3), XIII, 214
..	......	99.46	7.78	J. L. Smith.........	" " "
..	......	100.43	....	O. Bürger..........	1905, Meteoritenkunde, III, 379
..	......	99.77	7.863	L. Fletcher.........	1889, Min. Mag. VIII, 259
36	......	100.00	7.827	L. R. DeLoza.......	1876, Proc. Phila. Acad. Sci., 126
...	......	100.02	....	O. Bürger..........	1905, Meteoritenkunde, III, 320

b. RODEO GROUP

The nickel-cobalt content is somewhat higher than in the Pram-

RODI

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Alt-Biela	85.34	12.89	.41	....	....	.39	.06	.02	.....	.....	.86	....
Bear Creek	83.89	14.06	.83	tr.	....	.21	......	.....	.....	.....	....	....
Quesa	87.97	10.75	1.07	.04	....	.19	tr.	.....	.....	.....	....	....
Rodeo	86.95	11.27	1.20	.01	.03	.25	.01	.....	.....	.....	.07	....
"	89.84	8.79	.28	.07	....	.80	.02	.09	.....	.....	....	....

5. FINEST OCTAHEDRITES.

Width of lamellæ not exceeding 0.2 mm. The nickel-cobalt content lies, as a rule, between 10 and 15 per cent. Plessite strongly developed. Cohen divides the class into two groups, the Salt River group and the Tazewell group.

SALT RIVI

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Bacubirito	88.94	6.98	.21	....	....	.15	.005	.....	tr.	.....	....	....
"	89.54	9.40	.98	.02	.02	.12	.02	.01	.....	.02	....	Chromite, .
Ballinoo	89.34	9.87	.60	.06	....	.48	.03	.02	.....	.....	....	....
"	89.91	8.85	.74	tr.	....	.50	tr.	tr.	tr.	.....	....	....
Butler 2/2	89.12	10.02	.26	.01	....	.12	......	.....	.....	.....	....	....
Salt River	90.74	9.36	.....	....	....	......	tr.	.....	.....	.....	.26	Mg. Na., tr.
" 2/2	90.89	8.70	.85	.04	....	.34	tr.	.02	.....	.....	....	....

banan group, so that the group is a transition to the finest octahedrites.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	99.97	7.525	M. Neff & A. Stocky	1899, Prog.d.Böhm Gym.in Mahr-Ostrow
..	......	98.99	....	J. L. Smith	1867, A. J. S. (2), XLIII, 280
..	......	100.02	....	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H. XV, 379
..	......	99.79	....	O. Bürger..........	1905, Meteoritenkunde, III, 299
..	......	99.89	....	H. W. Nichols......	1905, Field Col. Mus. Geol. Ser. III, 4

a. SALT RIVER GROUP.

The content of nickel-cobalt is lower than in the Tazewell group, not exceeding 10½ per cent. Plessite predominates as compared with the Tazewell group. Schreibersite is common in numerous small, elongated individuals.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	96.285	7.69	J. E. Whitfield	1902, Proc. Roch. Acad. Sci. IV, 74
..	......	100.14	7.59	Cohen & Hildebrand	1903, Mitt. N. Ver. f. Neu Vorp. u. Rügen, XXXV, 13
..	......	100.40	7.8432	O. Sjöström........	1898, Ber. Berlin Akad., 19–22
..	......	100.00	7.8	Mariner & Hoskins.	1898, A. J. S. (4), V, 137
..	......	99.53	7.72	J. L. Smith.........	1877, A. J. S. (3), XIII, 213
..	......	100.36	....	W. H. Brewer......	1851, Proc. A. A. A. Sci. IV, 36-38
..	......	100.84	7.6648	J. Fahrenhorst	1900, Meteoreisen-Studien, X, A. N. H. XV, 76

b. TAZEWELL GROUP.

This group includes the octahedrites having the highest percent-

TAZEWEL

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Carlton...........	86.54	12.77	.63	.02	....	.16	.03	.11	....	....	....	....
Laurens County...	85.33	13.34	.87	....	....	.16	tr.	tr.	....	....	....	....
Mart.............	89.68	9.20	.33	.04	tr.	.16	.02	....	....	....	....	....
Mungindi.........	90.31	8.23	1.36	....	....	.09	tr.	.01	tr.	....	....	....
"	87.96	10.99	.88	.08	.03	.17	.21	....	....	....	....	....
Narraburra Creek.....4/4	88.60	9.74	.47	.01	....	.43	tr.	....	....	....	.72	Resinous matter
Tazewell........2/2	82.70	14.82	.46	.07	....	.18	.08	....	....	.02	....	Mg.O .24, SiO_2

c. COWRA AND VICTORIA WEST.

Cowra and Victoria West resemble the Salt River group in their predominance of plessite. Their place among the octahedrites is not

COWRA AN

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si,	Cl.	In-sol.	Miscellaneou
Cowra..........2/2	85.26	13.23	1.02	.02	....	.22	.01	.03	.01	....	....	Sn.and Mn.,
Victoria West.....	88.83	10.14	0.53	tr.	....	.28	.....	....	....	....	....	....

B. HAMMOND OCTAHEDRITES.

These meteorites appear in section to be granular aggregates in which black particles and taenite-like lamellæ extend in directions parallel to octahedral planes. They thus have resemblances to the octahedrites and form a transition to the ataxites. The structure by which they are characterized may be either original or secondary. If original, the structure has been produced by the separation of the nickel-rich alloy and black particles to form a web, the lines of which

HAMMON

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Cacaria...........	87.38	12.06	.65	.02	.01	.22	.05	....	....	....	.09	SiO_2 ...
"	92.00	7.70	.54	.03	.01	.24	.06	....	....	....	....	....
Hammond........	89.78	7.65	1.32	tr.	....	.51	.....	tr.	....	....	....	Sn. tr. SiO_2
"	91.62	7.34	1.01	.04	.01	.52	.01	.06	....	.01	....	....
Reed City........	89.39	8.18	....	....	....	.....	.....	....	....	....	....	....

age of nickel-cobalt. It reaches 15 per cent. and more. Taenite is strongly developed.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	100.26	7.95	L. G. Eakins.......	1890, A. J. S. (3), XL, 223–224
..	......	99.70	....	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 463–465
..	......	99.43	....	H. N. Stokes	1900, Proc. Wash. Acad. Sci. II, 53
..	......	100.00	7.4	Mariner & Hoskins.	1898, A. J. S. (4), V, 139
..	......	100.32	....	R. Knauer	1905, Meteoritenkunde, III, 269
..	......	99.98	7.57	A. Liversidge.......	1903, Proc. Roy. Soc. N. S. W. XXXVII, 240
..	......	99.22	7.89	J. L. Smith.........	1855, A. J. S. (2), XIX, 153

certain, however, and it seems desirable therefore to group them separately. Their percentage of nickel-cobalt resembles that of the finest octahedrites, 11 to 15 per cent.

CTORIA WEST.

ss.	Undet.	Total.	Sp. Gr,	Analyst.	Reference.
..	......	99.80	7.805	J. C. H. Mingaye ...	1904, Rec. Geol. Sur. N. S. W., VII, 31
..	......	99.78	7.692	J. L. Smith.........	1873, A. J. S. (3), V. 108

accord with octahedral planes. In the meshes of this web the nickel-poor remainder is deposited as a homogeneous, granular aggregate. If the structure is secondary, it may be explained by supposing that a normal octahedrite was somewhat softened by heat, so as to destroy the lamellar structure in part, after which solidification took place. If this latter be the correct explanation, the softening was carried farther in Hammond than in Cacaria and Reed City.

TAHEDRITES.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	100.64	7.7070	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H., XV, 362–363
..	......	100.58	....	"	Same
..	......	99.82	7.601–7.703	Fisher & Allmendinger	1887, A. J. S. (3), XXXIV, 383
..	......	100.62	7.288–7.506	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H., XV, 356
..	......	97.57	7.6	J. E. Whitfield	1903, Jour. Geol., XI, 233

C. BRECCIATED OCTAHEDRITES.

In these, as in the brecciated hexahedrites, the mass appears to be

BRECCIATE

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Barranca Blanca..	91.50	8.01	.65	tr.	....	.15	.13	.....	.....	.....	.03	....
N'Goureyma......	89.28	9.26	.60	.04	.11	.05	.77	.04	.....	.....	.24	Ce...... .c Chromite .c
"	91.99	7.15	tr.	....	....	......	......	.....	.....	.....	....	Fe.S.... .c Graphite, etc. ..
Santa Rosa .....⅔	91.46	7.72	....	....	....	......	......	.....	.....	.....	.28	....
"	92.30	6.52	.78	.02	tr.	.36	.04	.18	.....	.....	....	....
Tula	93.50	2.50	....	....	....	......	......	.....	.....	.....	....	Sn. tr. Schreibersite.. .
"	96.40	2.63	....	....	....	......	......	.....	.....	.....	....	Sn. .07 Sch. .
Zacatecas.........	89.84	5.96	.62	tr.	....	......	.13	.....	.....	.....	3.08	Mg. tr.
"	90.91	5.65	.42	....	....	.23	.07	.....	.50	.....	2.17	....
"	91.30	5.82	.41	tr.	....	.25	......	.....	.....	.....	2.19	Mg., tr.
"	92.09	5.98	.91	....	.74	1.02	......	.....	.....	.....	.04	....

made up of numerous individuals, the direction of whose lamellæ differs in the individual grains.

CTAHEDRITES.

oss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
...	......	100.47	7.823	L. Fletcher	1889, Min. Mag., VIII, 263
...	......	100.49	7.6722	E. Cohen	1901, Mitt. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIII, 14
...	......	99.36	7.31	S. Meunier.........	1901, Compt. Rendus, CXXXII, 444
...	......	99.46	7.30–7.60	Rivero and Boussingault ...	1824, Ann. Phys. Chem., XXV, 438–443
...	......	100.20	7.6896	O. Sjöström........	1899, Meteoreisen-Studien, VIII, A. N. H., XIV, 138
...	......	96.90	7.332	W. Haidinger	1861, A. J. S. (2), XXXII, 144
...	......	100.00	....	J. Auerbach	1863, Neues Jahrb., 362
...	......	99.63	7.20	H. Müller..........	1860, Jour. f. prakt. Chemie, LXXIX, 25
...	......	99.95	7.625	"	" " " "
...	......	99.97	7.50	"	" " " "
...	......	100.78	....	E. Cohen	1897, Meteoreisen-Studien, V, A. N. H., XII, 51

III. ATAXITES.

These iron meteorites are characterized by a fine granular to compact structure throughout. They show no evidence of the cubic cleavage and Neumann lines which characterize the hexahedrites, nor of the lamellar structure, octahedrally arranged, of the octahedrites. The individual grains are in some cases visible to the naked eye, but for the most part are of microscopic or sub-microscopic dimensions. In some occur peculiar streaks which seem to have crystallographic arrangement, but their exact relations have not been determined. These form a special group, which, while not ataxites in the strictest sense of the term, may be included among them for present purposes. The ataxites show the greatest variation among all iron meteorites in their nickel-cobalt content. This varies from 6 to 16 per cent, and in the doubtful Oktibbeha to 63 per cent. Two general

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Campo del Cielo .. (Wöhler's Iron.)	92.33	7.38		....	....	......	......	....	....	....	....	P. Fe. Ni. .4 Sn c
....	89 22	9.51		....	....	.20	......	tr.	....	....	....	Schreibersite. .o C. etc.... .2
....	94.25	5.11	.57	.03	.03	.18	.05	....	....	tr.	....	....
Cincinnati	94.47	5.43	.68	.01	....	.05	.05	....	....	....	....	....
Locust Grove	94.30	5.57	.64	tr.	....	.18	.05	.02	....	.01	....	....
San Francisco del Mezquital	93.38	5.89	.39	....	....	.23	......	....	....	....	....	....
" "	93.36	5.46	.87	.03	....	.16	.15	....	....	....	....	....
Siratik (Senegal)..	94.07	5.21	.77	.01	....	.26	.04	.01	....	....	....	....

subdivisions may be made of the ataxites, according as they are nickel-poor or nickel-rich. Transitions occur between these, but a general grouping is practicable. Accessory constituents are not usually abundant in the ataxites, and when occurring are of small dimensions as a rule.

A. NICKEL-POOR ATAXITES.

The nickel-cobalt content lies between 6 and 7 per cent, the composition thus corresponding to that of kamacite. The structure is, as a rule, plainly granular, seldom compact, the size of the grains reaching 0.75 mm.

1. SIRATIK GROUP.

An etched surface appears rough through the presence of irregularly arranged depressions, due perhaps to the solution of some accessory constituent, such as troilite or schreibersite. The smaller the depressions the more plainly the boundaries of the grains appear. The latter range from 0.33 to 0.75 mm. in dimension.

:OUP

ss.	Unde.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	100.16	7.547	N. S. Manross......	1853, A. J. S. (2), XV, 22
..	......	99.23	7.85	C. Martius	Ann. Chem. u. Pharm., CXV, 92
..	......	100.28	7.7679	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 124
..	......	100.69	7.6895	"	1898, Ber. Berlin Akad., 428–430
..	......	100.77	7.7083	"	1897, Ber. Berlin Akad., 76–81
..	......	99.89	7.83	A. A. Damour......	1868, Comptes Rendus, LXVI, 573–574
..	......	100.03	7.7687	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A. N. H., XV, 365
..	......	100.37	7.7752	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 131

2. NEDAGOLLA GROUP.

Both granular and compact irons occur in this group. They lack the rough appearance of the Siratik group on etched surfaces. The

NEDAGOLL[A GROUP.]

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Chesterville.......	95.00	5.00	.....	....	tr.	tr.	......	.....	.....	.....	....	....
"	93.15	5.82	.73	....	....	.34	......	.....	.....	.....	....	....
"	93.80	5.50	.75	.02	tr.	.34	.03	.02	.....	.....	....	....
Forsyth County...	94.90	4.18	.33	....	....	tr.	.22	.....	.....	.....	....	....
(Compact portion.).	94.03	5.55	.53	.02	....	.23	.03	.02	.....	tr.	....	....
(Granular portion).	94.18	5.56	.60	.02	....	.19	.05	.04	.....	.17	....	....
Nedagolla	92.61	6.20	.49	tr.	....	.02	.05	.....	.25	.....	....	....
Nenntmansdorf ...	94.50	5.31	.....	....	....	......	......	.....	.....	.....	....	....
" ...	93.04	6.16	.....	....	....	.22	......	.....	.....	.....	....	....
" ...	94.33	5.48	.71	....	....	.29	......	.....	.....	.....	....	....
Primitiva	94.72	4.72	.71	tr.	....	.18	.02	.03	.....	.....	....	....
Rasgata	90.76	7.87	.....	....	....	......	......	.....	.....	.....	....	....
"	92.35	6.71	.25	tr.	....	.35	tr.	.....	.....	.....	....	P. Fe. Ni. . Silicates . . Sn. ......
"	92.81	6.70	.64	.01	tr.	.28	.08	.19	.....	.....	....	....

3. RAFRUTI GROUP.

The members of this group resemble the granular members of the

RAFRU[TI GROUP.]

Name.	Fe.	Ni.	Co.	Cu.	Cr	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous.
Illinois Gulch......	92.51	6.70	.16	....	....	.62	......	.01	tr.	.....	....	....
" 2/2	86.77	12.67	.81	.02	.01	.08	tr.	.....	.....	.....	....	....
Rafrüti	89.87	9.54	.61	.03	.01	.06	.11	.18	.....	.....	....	....

size of the grains in the granular members is generally less than 0.5 mm., rarely 0.75 mm. No granular structure is visible, even on strong magnification, in the compact members. Chesterville and Rasgata are rich in rhabdite.

.OUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference
..	......	100.00	7.82	C. U. Shepard	1849, A. J. S. (2), VII, 449
..	......	100.04	....	O. Sjöström	1897, Meteoreisen-Studien, V, A. N. H., XII, 47
..	......	100.46	7.8209	"	1898, Meteoreisen-Studien, VIII, A. N. H., XIV, 150
..	......	99.63	....	E. A. de Schweinitz	1896, A. J. S. (4), I, 208–209
..	......	100.41	7.4954	O. Sjöström	1897, Ber. Berlin Akad., 386–396
..	......	100.81	7.3357	"	" " "
..	......	99.62	7.8613	"	1897, Meteoreisen-Studien, VI, A. N. H., XII, 121
..	......	99.81	....	G. E. Lichtenberger	1873, Sitz. Isis. p. 4, Dresden
..	......	99.42	6.21	E. Geinitz	1876, Neues Jahrb., 609
..	......	100.81	7.8241	E. Cohen...........	1897, Meteoreisen-Studien, V, A. N. H., XII, 42
..	......	100.38	....	O. Sjöström	1897, Meteoreisen-Studien, VI, A. N. H., XII, 123
..	......	98.63	7.6	Rivero and Boussingault....	1824, Ann. Chem. Phys., XXV, 442–443
..	......	100.11	7.33–7.77	F. Wöhler..........	1852, Ann. Chem. Pharm., LXXXII, 243–248
..	......	100.71	7.654	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 143

Nedagolla group, but have an essentially higher nickel-cobalt content, and thus form a transition to the nickel-rich ataxites.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	100.00	7.7	Mariner and Hoskins	1900, A. J. S. (4), IX, 201–202
..	......	100.36	7.8329	J. Fahrenhorst......	1900, Meteoreisen-Studien, XI, A. N. H., XV, 353
..	......	100.41	7.596	Cohen and Hildebrand.....	1902, Mitt. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIV, 87

B. NICKEL-RICH ATAXITES.

These ataxites are fine-grained to compact, and acquire, as a rule, on weak etching, a characteristic varnish-like luster. Stronger etching produces a dull surface, having a peculiar velvety sheen. The

SMITHLAN

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Babb's Mill (Troost Iron)	85.30	14.70	.....	....	....	......	......	.....	.....	.....	....	Al. Mg. Ca., t
"	87.16	9.76	.....	....	....	......	......	.....	.....	.....	....	....
"	80.59	17.10	2.04	....	....	......	......	.....	tr.	.....	.12	Mn. ...... .t P. Fe. Ni. .1
"	81.54	17.74	1.26	....	....	.11	......	.....	.....	.....	....	P. Fe. Ni. .c
"	81.45	17.30	1.67	.03	.03	.12	.01	.07	.....	.....	....	....
(Blake Iron)	91.42	7.95	.....	....	....	......	......	.....	.....	.....	....	....
"	86.30	12.58	1.66	....	....	......	......	.....	.....	.....	....	....
"	88.23	11.01	.72	....	.02	tr.	tr.	.03	.....	.01	....	....
"	88.41	11.09	.66	....	.02	tr.	tr.	.03	.....	.02	....	....
Botetourt	85.88	18.23		....	....	......	......	.....	.....	.....	....	....
Deep Springs	87.01	11.69	.79	....	....	.04	......	.....	.53	.39	....	....
"	85.99	13.44	.70	.03	.03	.06	......	.02	.....	.02	....	....
Dehesa	86.20	14.20	.....	....	....	......	......	.....	.....	.....	....	....
Linville	84.56	14.95	.33	....	....	tr.	.12	tr.	.....	.....	....	....
"	83.13	16.32	.76	.02	....	.23	.02	.11	.....	.....	....	....
Morradal	79.67	18.77	1.18	.06	.06	.18	.27	.....	.....	.....	....	....
Smithland	82.83	16.42	.94	....	.06	.09	.17	.....	.....	.....	....	....
Weaver	80.78	17.92	.84	....	....	.12	.15	.....	.....	.....	.15	....

nickel-cobalt content lies, for the most part, between 14 and 20 per cent, though it drops to 12 and rises to 26½ per cent.

1. SMITHLAND GROUP.

The nickel-cobalt content does not exceed 20 per cent.

:OUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	100.00	7.548	C. U. Shepard	1847, A. J. S. (2) IV, 76–77
..	......	96.92	....	G. Troost	1845, A. J. S. (1), XLIX, 342–344*
..	......	99.85	7.839	W. S. Clark........	1852, Metallic Meteorites, 65–66
..	......	100.70	7.7948	E. Cohen	1892, Meteoreisen-Studien, II, A. N. H., VII, 147, 148
..	......	100.68	....	J. Fahrenhorst	1900, Meteoreisen-Studien, X, A. N. H., XV, 93
..	......	99.37	7.858	W. P. Blake........	1886, A. J. S. (3), XXXI, 44
..	......	100.54	....	Cohen and Weinschenk.....	1891, Meteoreisen-Studien, I, A. N. H., VI. 142–143
..	......	100.02	....	J. Fahrenhorst	1900, Meteoreison-Studien, X, A. N. H., XV, 93
..	......	100.23	....	"	Same
..	......	104.11	8.186	O. Sjöström........	1898, Meteoreisen-Studien, VII, A. N. H., XIII, 49
..	......	100.45	....	F. P. Venable......	1890, A. J. S. (3), XL, 162
..	......	100.29	7.4538	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A. N. H., XV, 355
..	......	100.40	7.8892	J. Domeyko........	1879, Mineralojia, Santiago
..	......	99.96	....	J. E. Whitfield	1888, A. J. S. (3), XXXVI, 276
..	......	100.59	7.4727	O. Sjöström........	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 147
..	......	100.19	7.8543	"	1898, Videnskabsselskabets Skrifter (1), VII, 11
..	......	100.51	7.7115	"	1898, Meteoreisen-Studien, VII, A. N. H., XIII, 47
..	......	99.96	7.12	Lindner...........	1904, Sitzb. K. Preus. Akad. der Wiss. XXXII

*As recalculated by Cohen, Meteoritenkunde, Heft III, p. 104.

2. CRISTOBAL GROUP.

The nickel-cobalt content exceeds 20 per cent.

CRISTOB

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Limestone Creek..	65.18	27.71	.....	....	....	......	......	.....	.....	.....	....	....
" " ..	66.56	24.71	.....	....	....	......	4.0	.....	.....	1.48	....	Cr.&Mn. 3.
" " ..	83.57	12.67	.....	....	....	......	......	.....	.....	.91	....	FeS_2 .... 2.
" " ..	65.03	29.99	1.48	....	....	.19	......	.....	.....	.....	....	....
San Cristobal	73.72	25.60	1.0	....	....	.18	......	.....	.....	.....	....	....

3. OKTIBBEHA.

The meteoric origin of Oktibbeha is doubtful, on account of its

OKTIBBEH

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneou
Oktibbeha	37.69	59.69	.40	.90	....	.10	......	.....	.12	.....	....	Al...... . Ca...... .
"	37.24	62.01	.72	.28	....	.15	......	.....	.....	.....	....	....

C. ATAXITES WITH ACCESSORY FORSTERITE.

The accessory occurrence of forsterite is characteristic. It forms about five per cent of the mass, occurring in small spheroidal grains or elongated aggregates ot grains, and is accompanied by some plagioclase. In nickel-cobalt content the metallic portion of the meteorite

ATAXITES WIT

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	$Si.O_2$	Cl.	In-sol.	Miscellaneou
Tucson	85.54	8.55	.61	.03	....	.12	......	.....	3.02	.....	....	MgO 2.04 Cr_2O_3 Al_2O_3, tr.
"	83.55	9.20	.39	.01	.17	.13	......	.....	3*.01	.....	....	Labradorite. 1. CaO .51 MgO 2.
(Carleton Iron)......	81.56	9.17	.44	.08	....	.49	......	.....	3.63	.....	....	FeO .12 CaO 1 MgO 2.43 0
"	84.56	8.89	1.36	.03	.02	.16	tr.	.04	1.72	.04	....	MgO .. . Chrys. res. 3.
(Ainsa Iron)	84.60	9.24	.95	.02	.02	.17	.01	.04	1.76	.04	....	MgO .. . Chrys.res.. 3.

* K_2O, .10; Na_2O, .17.

OUP.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	92.89	5.75	C. T. Jackson.......	1838, A. J. S. (1), XXXIV, 335
..	......	99.99	5.75–6.40–6.50	"	" " " "
5	......	100.00	6.82	A. A. Hayes........	1845, A. J. S. (1), XLVIII, 153
..	......	96.89	....	R. Knauer	1905, Meteoritenkunde, III, 131
..	......	100.50	7.8593	"	1899, Ber. Berlin Akad., 607–608

anomalous composition. It may however for the present be included among meteorites.

OUP.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..	......	99.19	6.854	W. J. Taylor	1857, A. J. S. (2), XXIV, 294
..	......	100.40	....	E. Cohen	1892, Meteoreisen-Studien, II, A. N. H., VII, 146

lies between the nickel-rich and nickel-poor ataxites. On etching, irregularly shaped areas appear, 0.2–2 cm. in area, which under the microscope have a spotted look and are generally bordered, as are most of the silicate grains, by narrow, zigzag bands the nature of which cannot be further determined.

CESSORY FORSTERITE.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.	......	100.12	6.52–7.13	J. L. Smith	1855, A. J. S. (2), XIX, 161–162
.	......	100.55	....	F. A. Genth........	1855, A. J. S. (2), XX, 119–120
.	......	99.69	7.29	G. J. Brush.........	1863, A. J. S. (2), XXXVI, 153
.	......	101.09	7.2248	J. Fahrenhorst......	1900, Cohen-Festschrift, Greifswald, 39
.	......	100.75	....	"	" " "

D. ATAXITES WITH CUBIC STREAKS.

Upon etching appear bands or spots which seem to be oriented according to cubic faces, and which according to the position of the plates toward impinging light appear brighter or darker than the principal mass of the nickel-iron without a structural distinction being discernible. In one position the reflection of the whole face is plainly uniform. On weak etching appears, as a rule, a characteristic luster.

ATAXITES WIT

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Cape of Good Hope	78.90	15.28	1.0	....	....	......	......	....	....	....	....	Ca. 1.41, Al. Mg. .15, Mn. 1 Graphite 1
"	85.61	12.27	.89	....	....	......	......	....	....	....	....	....
"	81.20	15.09	2.56	tr.	....	.09	tr.	....	....	....	:95	Sn.......
"	81.30	15.23	2.01	tr.	....	.08	tr.	....	....	....	....	P. Fe. Ni. Sn.......
"	82.77	14.32	2.52	tr.	....	.26	......	....	....	....	....	....
"	82.87	15.67	.95	.03	.04	.09	......	.03	....	.01	....	....
Iquique..........	83.83	15.86	.19	....	....	.05	......	....	....	....	.07	....
"	83.49	15.41	.94	.02	tr.	.07	.02	.03	....	....	....	....
Kokomo..........	87.02	12.29	.65	tr.	....	.02	......	....	....	....	....	....
"	83.24	15.76	1.07	.01	....	.08	tr.	....	....	....	....	....
Shingle Springs...	88.02	8.88	....	....	....	......	......	....	....	....	3.5	....
" ...	80.74	15.73	....	....	....	......	......	....	....	....	....	Sn....... P. etc....3.
" ...	81.48	17.17	.60	....	.02	.31	.01	.07	.03	....	....	Ca. .16, Al. Mg. .01, K.
" ...	82.21	16.69	.65	.02	.02	.34	.05	.03	....	....	....	....
Ternera	83.02	16.22	1.63	tr.	....	......	......	....	....	....	....	....
"	82.17	16.22	1.42	....	....	.11	.13	....	....	....	....	....

On strong etching the surface becomes dull with a peculiar velvet sheen. No cleavage has been observed. On the other hand, a certain orientation of similarly situated particles is indicated by the appearance in reflected light. The structure of the nickel-iron is compact; the content in nickel plus cobalt 16–17 per cent. Except for the etch bands, the members of this group are similar in chemical composition and luster to the etched faces of members of the Morradal group.

BIC STREAKS.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.	......	100.00	7.544	V. Holger..........	1830, Zeit f. Phys. u. Math., VIII, 279–284
.	......	98.77	7.66	A. Wehrle.........	1835, Zeit. f. Phys. u. Math. (2), III, 222–229
.	......	99.89	6.63–7.94	E. Uricoechea......	1854, Ann. Chem. u. Pharm., XCI, 252
.	......	99.50	7.60	M. Böcking	1855, Ann. Chem. u. Pharm., XCVI, 243–246
.	......	99.87	7.71	Baumhauer and Seelheim ...	1867, Arch. Neerland, II, 376–384
.	......	99.69	7.8543	J. Fahrenhorst	1900, Meteoreisen-Studien, X, A. N. H., XV, 87
.	......	100.00	7.925	C. Rammelsberg....	1873, Fest. Ges. Natur. Freunde, Berlin, 37
.	......	99.98	7.8334	O. Sjöström........	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 153
.	......	99.98	7.821	J. L. Smith.........	1874, A. J. S. (3), VII, 392
.	......	100.16	7.8606	O. Sjöström........	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 118–158
.	.....	100.00	7.80	C. U. Shepard......	1872, A. J. S. (3), III, 438
.	......	100.00	7.9053	C. T. Jackson.......	1872, A. J. S. (3), IV, 495
.	......	99.98	7.875–8.024	F. A. Cairns........	1873, A. J. S. (3), V, 21
.	......	100.01	7.8943	O. Sjöström........	1898, Meteoreisen-Studien, IX, A. N. H., XIII, 479–480
.	......	100.87	7.694	E. Weinschenk.....	1892, A. J. S. (3), XLIII, 425
	......	100.05	....	Lindner............	1904, Ber. Berlin Akad., 151

ANALYSES OF OCCLUDED GASES.

The occluded gases of nine iron meteorites have been determined. These are here shown.

Name.	Vols.	H.	CO_2	CO.	N.	CH_4	Analyst.	Reference.
Charlotte	2.20	71.40	13.30	15.30	.....	.....	A. W. Wright..	1876, A. J. S. (3), XI, 257
Cranbourne	3.59	45.79	0.12	31.88	17.66	4.55	W. Flight	1882, Ph. Tr. Roy. Soc. London, 893 896
Lenarto	2.85	85.68	.....	4.46	9.86	.....	Th. Graham ...	1866, Proc. Roy. Soc., London, XV, 502–503
Magura	47.13	18.19	12.56	67.71	1.54	.....	A. W. Wright..	1876, *op. cit.*
Red River.....	1.29	76.79	8.59	14.62	.....	....	A. W. Wright..	1876, *op. cit.*
Rowton	6.38	77.78	5.15	7.34	9.72	.....	W. Flight	1882, *op. cit.*
Shingle Springs	0.97	68.81	13.64	12.47	5.08	.....	A. W. Wright..	1876, *op. cit.*
Staunton	3.17	35.83	9.75	38.33	16.09	.....	J. W. Mallet ...	1871, Proc. Roy. Soc. London, XX, 365–370
Tazewell	3.17	42.66	14.40	41.23	1.71	.....	A. W. Wright..	1876, *op. cit.*

DISCUSSION OF ANALYSES.

The most striking feature brought out by the analyses is the relation shown between chemical composition and structure. This seems to be definite and general. All the meteorites of a hexahedral structure have a nearly uniform composition, while among the octahedral meteorites, fineness of structure increases with increase of nickel. This conclusion can best be shown by obtaining the averages from the analyses of the different groups, omitting all obviously faulty analyses. The results thus obtained are as follows:

Class.	No. of Analyses.	Width of Lamellæ in Millimeters.	Per Cent Fe.
Hexahedrites............	29	------	94.12
Coarsest Octahedrites....	12	+ 2.5	93.18
Coarse "	22	2.0–1.5	92.28
Medium "	88	1.0–0.5	90.64
Fine "	41	0.4–0.2	90.18
Finest "	13	0.2– —	88.51

It is worthy of note that these averages are not means between wide limits, but are derived from nearly uniform values. Practically all of the members of the classes conform in composition to the average. Were all the groups equally well known, it is probable, too, that the gradation of percentage of Fe would be even more uniform than here shown. The medium octahedrites, for example, while numerous, have been as a whole imperfectly analyzed. Moreover, some of the meteorites classed as medium octahedrites, which are characterized by low percentage of iron, such as Algoma and Glorieta Mountain, have width of lamellæ such as to place them near if not in the fine octahedrites.

The apparent conclusion from the above results is, that the content of nickel influences the structure. It may also account for the change from a hexahedral to an octahedral structure, since the irons with a hexahedral structure have the lowest per cent of nickel. So constant and definite does this relation hold, that given a certain structure the per cent of nickel can probably be stated more accurately by this principle than it has been determined in some analyses. The per cent of nickel in iron meteorites as a whole, as shown by the reliable analyses, lies between five and twenty-six per cent. An exception to the latter figure may be found in the quoted analyses of Limestone Creek, but of this unfortunately no complete analysis exists. The somewhat doubtful Oktibbeha is also an exception, its percentage of nickel reaching sixty per cent. Cobalt in the iron meteorites rarely exceeds one per cent. No constant relation in amount appears to exist between it and nickel, although perhaps as a rule it is higher with higher nickel. Copper is doubtless, as claimed by Smith, a constant ingredient of iron meteorites. It is usually only a few hundredths of one per cent in amount, but may reach a few tenths. Chromium is shown by the analyses to be a frequent though not constant ingredient in minute quantities. In many cases it is probably present as daubreelite, but also, as suggested by Cohen, it may occur as an element alloyed with nickel-iron. Reports of the presence of manganese and tin are so frequent as to leave little doubt that they occur in many iron meteorites, perhaps alloyed as metals. The presence of platinum and iridium has been proved by Davison in Coahuila and Franceville, and doubtless could be found to exist in more meteorites if proper search were made. Gold was reported in Boogaldi by Liversidge, but in so small a quantity as to make its determination as yet not quite positive. The presence of occluded gases has been determined in but few cases. The constant presence of phosphorus in iron meteorites is a feature shown by the analyses. Apparently no iron meteorite is lacking in this element altogether, and in amount and constancy it considerably exceeds sulphur. It probably occurs combined with nickel-iron as phosphide. Sulphur, though evident by its presence in many meteorites as troilite, does not appear in large amounts in the analyses, and does not seem to be so important or constant an ingredient as phosphorus. Carbon is probably more frequent in occurrence than analyses usually show, since of twenty-eight iron meteorites investigated by Cohen for carbon all but one showed appreciable percentages, ranging from .19 per cent to .012 per cent.* The silicon reported in the analyses is doubtless in some cases to be referred to silicate grains, but in other cases may be free or combined with the iron as a silicide. The analyses make plain the incompleteness of much of the work which has been done hitherto. There can be little doubt that complete analyses of iron meteorites should always show iron, nickel, cobalt, copper, and phosphorus, and in most cases sulphur, carbon, and silicon. When considerable differences occur in the analyses of the same meteorite, as, for instance, 2 per cent of nickel reported in Burlington by Rockwell and nearly 9 per cent by Shepard, the difference is probably not to be regarded as due to the meteorite, but to the analyses. In a substance made up of different alloys and accessory minerals as are the iron meteorites, especially the octahedrites, there can be no question that portions from different parts of the meteorite would of necessity show unlike composition. How wide these variations might legitimately be it is difficult to say, but some causes of error may be suggested. One of these is imperfect sampling. The proper method to secure material for mass analyses of an iron meteorite, especially if of octahedral structure, is to use dust obtained by boring. A mixture of the constituents of the meteorite is thus obtained which insures a better representation of its composition than is possible when only a fragment broken from some part of the surface is used. Such a fragment may contain an excess of taenite, or be largely composed of some accessory mineral so as to be far from representing the true constitution of the meteorite. Yet the larger number of analyses of iron meteorites have probably been made with fragments of this character, and the wonder is, not that they show so much variation, but that they do not show more. Meteorites also doubtless vary in their homogeneity, as shown especially by Canyon Diablo, in one portion of which Moissan found 2.89 per cent of nickel, and in another, only one centimeter distant, 5.06 per cent. In another piece of Canyon Diablo two analyses made by the same analyst of material obtained at distances of one centimeter showed 1.17 per cent and 7.11 per cent of

* Meteoritenkunde, Heft II., p. 243.

nickel.* While few meteorites probably vary to this extent, such determinations show the need of as thorough sampling as possible if a mass analysis is to be made. Occasionally a marked variation in the analyses of a meteorite seems explicable only on the assumption that the material analyzed did not belong to that meteorite. Such, for instance, seems the most reasonable explanation for the percentage of nickel, 12.67 per cent, reported by Hayes for Limestone Creek, as compared with the percentages, 25–30 per cent, obtained by other analysts. Errors of this sort are obviously difficult to detect, and can only be surmised in extreme cases. Another and more serious cause of discrepancies in analyses is the imperfect separation by the analyst of nickel and cobalt from the iron. The methods for this separation are not altogether satisfactory, even at the present day, and in earlier years they were much less so. Consequently the results of the earlier analysts were for the most part too low in these ingredients. The determinations of specific gravity shown in the tables appear in some cases to have been equally open to sources of error with the analyses. It can easily be calculated that the specific gravity of an iron meteorite is likely to be between 7.6 and 7.9, since the specific gravity of pure iron, 7.85, will be increased by that of nickel, 8.8, according to the proportion of the latter. It will be decreased by accessory minerals, such as troilite, which has a specific gravity of 4.7, schreibersite, 6.5, graphite, 2.2, and oxidized ingredients. Any porosity of the meteorite will also lessen its specific gravity. It is obvious, therefore, that determinations of specific gravity made on small fragments can hardly represent that of the mass as a whole, since they may contain a disproportionate quantity of accessory ingredients or may be more oxidized than the main mass. It is hardly credible that porosity or accessory ingredients of a meteorite would in any case reduce its specific gravity below 7. Determinations below this figure, therefore, probably indicate that oxidized material was used. From the showing in the tables that large numbers of meteorites have practically similar composition, it is evident that similarity of composition cannot be used, as has often been done hitherto, to prove identity of origin of meteorites found at different places. This method at one time obtained considerable vogue. Dissimilarity of composition, on the other hand, as a rule indicates separate falls. The only marked exception to this rule seems to be furnished by the two masses of Babb's Mill, one of which shows about 11 per cent, the other about 17 per cent, of nickel. The only alternative supposition possible here

* C. R., 1893, cxvi., 290.

is that two ataxites fell at different times at one locality. In view of the small number of ataxites known, this seems less likely than to suppose that two masses of the same fall differed in composition. No other case of such marked difference is known. Differences of structure seem as a rule to be a better criterion for distinguishing meteorites than differences of composition. On the other hand, similarity of structure and composition together do not positively identify meteorites found at different places as belonging to one fall, since such similarities occur in meteorites seen to fall at widely different times and places. Of the nine iron meteorites seen to fall, four are medium octahedrites and have practically similar compositions. In correlating individual meteorites, therefore, all possible characters must be taken into consideration, including the circumstances of their find, the appearance of their exterior, the probable time elapsed since their fall, etc.

No attempt has been made by the writer at summation of the analyses here given, in order to determine the average composition of iron meteorites. Such a summation, if worthy of being performed at all, will be deferred until analyses of the iron-stone and stone meteorites are also at hand for comparison. This work the writer hopes to accomplish in the near future. It is obvious, however, from an inspection of the tables that the average percentage of iron in iron meteorites as a whole is not far from 91 per cent, while that of nickel closely approximates 7.50 per cent. It is doubtful if the average percentage of the remaining minor constituents can be learned by summation of existing analyses. Not only have these constituents in many cases not been determined, but also any slight error in analyses or sampling would double or multiple their percentage. A percentage of .4 of cobalt, for instance, as compared with .2, is within the limits of error of many analyses, yet one percentage is double that of the other. The same is true in much greater degree of determinations of the amount of copper and other constituents. Until a larger number of complete and accurate determinations are at hand, therefore, summations of these constituents seem to have little value. One point in the composition of iron meteorites which may or may not be of significance may be noted. Of the four constant metallic constituents, the most abundant, iron, has the lowest atomic weight, the next in quantity, nickel, is next higher, and so on for cobalt and copper. This gradation, using percentages common in iron meteorites, appears as follows:

	Iron.	Nickel.	Cobalt.	Copper.
Per cent in iron meteorites	90	9	0.9	0.02
Atomic weight	55.5	58.3	58.6	63.1